Antiquity 2021 Vol. 95 (383): 1315–1330
https://doi.org/10.15184/aqy.2021.116

Research Article

The Anthropocene, hyperobjects and the archaeology of the future past

Peter B. Campbell*

* Cranfield Forensic Institute, Cranfield University, UK (✉ p.campbell@cranfield.ac.uk)

Archaeology is often defined as the study of the past through material culture. As we enter the Anthropocene, however, the two parts of this definition increasingly diverge. In the Anthropocene the archaeological record ceases to be observed from a distance, but is something we exist within. It is not an assemblage of material culture, but a hyperobject of vast temporal and geographical scope, in which ecofacts increase in prominence and the role of artefacts recedes. This article examines the archaeological record as a hyperobject and argues for an expanded definition of archaeology for the future past. It argues for a shift from the study of objects towards a broader archaeology that includes immaterial Anthropocene culture.

Keywords: Anthropocene, object-oriented ontology, hyperobject, future

Introduction

The human species has recently begun to reckon with the consequences of its impact on the Earth. Geologists have proposed a new epoch, named the Anthropocene, to delineate between the Holocene and one characterised by the effect of humans on the planet—primarily anthropogenic climate change (Crutzen 2002). Evidence of this geological layer was first identified in ice cores, which show increasing carbon dioxide and methane starting in the late eighteenth century (Crutzen 2002: 23). Recent studies have gone further, demonstrating that the Anthropocene is stratigraphically distinct from the Holocene through layers containing plastics, chemicals and radiation (Waters *et al.* 2016). It is therefore increasingly evident that archaeologists in the future will have significantly different datasets and methods. What will the archaeology of our present—the 'future past'—look like?

Traditionally, the archaeological record has been conceptualised as artefacts, features, sites and ecofacts, linked through geographical, temporal or cultural boundaries (e.g. Mesoamerican, Bronze Age, Minoan) (Binford 1964). These categories, however, have proven problematic (Olsen *et al.* 2012: 8). In lieu of the global layers that delineate the Anthropocene, it is necessary to expand the scope of the archaeological record beyond traditional definitions that are bounded by sites or cultures. In response to global warming, a theory of time-transgressive entities of vast geographical scope, known as *hyperobjects*, has

Received: 25 July 2020; Revised: 7 December 2020; Accepted: 11 December 2020

been developed (Morton 2013). Edgeworth (2018) argues that archaeological strata have active environmental agency and constitute more than just a 'record'—a term that denotes passivity. Instead, he proposes an "archaeosphere" that comprises the "totality of archaeological evidence or humanly modified ground [which] can itself be considered a hyperobject" (Edgeworth 2016: 107). He envisions that the lithosphere, hydrosphere, atmosphere, biosphere and archaeosphere all intermesh (Edgeworth 2018: 23).

The term 'hypanthropos' has been proposed by Witmore (2014) to replace the unspecified 'anthropos' of the Anthropocene, and signal the emergence of a radical transformation—in his words "a metabolic assemblage in excess of monstrosity"—found in soil, water and air (Witmore 2014, 2019: 140–41). Hypanthropos combines hyper and hypo to convey a sense of something both beyond and beneath past understandings of anthropos. As these past definitions of anthropos were formulated on grounds different from this "outrageous aggregate monstrosity", Witmore (2019: 143) suggests 'Hypanthropocene' as a more fitting term for this epoch.

A human-generated hyperobject, which exceeds human individuals themselves, comprises archaeological sites, global warming and ozone depletion. Due to the spatial and temporal scale of the hyperobject, it is something that we exist inside. Pétursdóttir (2017: 182 & 194) writes: "The very reason we speak of the Anthropocene is not that we have lost connection with the past but rather that we increasingly are unable to pretend that it's gone" and it is "overwhelmingly present and threatening". Objects possess hidden aspects that are not fully comprehensible, which Harman (2018: 12) terms their "darkness". 'Dark' artefacts, such as radioactive waste, are found in the Anthropocene (Hudson 2014), and Anthropocene archaeology examines "how they endure and outlive us, and how they interact outside our control and domain" (Pétursdóttir 2017: 194). Material culture, which is currently at the heart of archaeology, plays a diminished role in the Anthropocene hyperobject, which extends beyond physical objects. As the role of artefacts recedes, future archaeologists will rely more on ecofacts, and perhaps new categories of archaeological information, to write past narratives.

The archaeological record as a hyperobject

The 'speculative turn' in philosophy challenges correlationism, or the subject-object relations that have typified philosophy since Kant, in favour of flat ontologies that do not privilege the human mind over external entities (Harman 2018: 12). Archaeology has contributed significantly to flat ontologies through symmetrical archaeology (Witmore 2007; Olsen *et al.* 2012), among other object-oriented approaches (archaeologists new to such approaches may find the term 'entity' more suitable than 'object' due to the pre-existing usage of the latter within the field). Object-oriented ontology is a prominent flat ontology, which argues that real objects are withdrawn or withheld, in the Heideggerian sense, and we only perceive their sensual properties where they come into contact with other objects (Harman 2018: 7). Object-oriented ontology is significant for the present discussion, as it has identified a type of previously unacknowledged object, which Morton (2013) names *hyperobject*. It describes entities of vast temporal and geographical scope, such as black holes and global warming. The Big Bang, for example, dates to the beginning of time and we cannot see it, but its gravity waves are passing through our bodies right now (Morton 2013: 64). We cannot perceive them directly with our sensory organs, but the Big Bang's residue is visible every time

we see static on a television. Thus, we live inside the Big Bang hyperobject and perceive it only using instrumentation. Hyperobjects can also be biological, such as the biosphere or phytoplankton colonies, and Morton (2013: 58) conceived of hyperobjects to understand the biological creation—by humans—of global warming.

Due to their vast scale, hyperobjects present conceptual and methodological challenges. Their geographical and temporal scale makes them "thinkable", but not directly observable (Morton 2013: 12). As a result, we observe aspects of hyperobjects, rather than the whole object, interacting with other entities. This means that hyperobjects simultaneously inhabit small and vast spaces, which makes their appearance "strange" or "uncanny" (Morton 2013: 55). Global warming is evident through scientific instruments, but is not directly observable. Instead, we have local experiences such as extreme weather events or increasingly frequent sunburn. These manifestations are not global warming itself, but the effects of it interacting with other objects (e.g. sea, skin). Morton (2013) refers to this as 'nearness' and 'stickiness', as the hyperobject cannot be avoided even if it appears far away. We cannot see the Big Bang or global warming, but their effects are all around us. Global warming is not only a hyperobject, it is also a component of a broader hyperobject that encompasses human residue on Earth. "Residue" (Edgeworth 2018: 19) is an apt term, as it describes the unintentional vestiges of human activity, and reflects hyperobjects' 'stickiness' and 'indifference'.

In object-oriented ontology, an object is anything that "is more than its pieces and less than its effects" (Harman 2018: 53). Human activity is the commonality between a series of ecological crises, including global warming, the sixth mass extinction, and global layers of radiation, chemicals and plastics. It is evident that human 'residue' on Earth is an object that produces effects on a geographical and temporal scale, and that qualifies as a hyperobject.

As a field that examines timescales beyond human lifetimes, archaeology is well suited to consider hyperobjects (Witmore 2007). But why is the archaeological record a hyperobject, rather than a biological byproduct, as other species produce? First, if humans vanished today, the hyperobject would continue to exist for centuries. The global radiation layer will remain for over 20 000 years (Waters *et al.* 2016) and radioactive waste for 250 000 years (Rao 2001). Other aspects, such as the hole in the ozone layer and anthropogenic climate change, would continue for centuries.

Second, there is no part of Earth that is not affected. Human culture is sticky and clings to everything. Humans are an ecosystem-independent species numbering over seven billion, and their effect is global. Climate change is altering DNA and causing migrations and behavioural changes (Caldwell *et al.* 2007). We can identify the direct effects of the hyperobject, such as global warming, extinctions and increasing ultra-violet (UV) radiation, and the cultural reactions, such as hybrid cars, nature parks and sunscreen. Greenhouse gases and rising temperatures are consequences of culture and reveal information about the human experience, but they also affect culture and are not 'material'. Thus, the archaeological record is not an assemblage of material culture, but an archaeosphere or hypanthropos, with agency.

It is debated whether the Anthropocene began in 1945, or with the Industrial Revolution, or with hominin control of fire 400 000 years ago (Steffen *et al.* 2015; Scott 2017). Witmore (2014: 129) contends that searching for the Anthropocene's origin is futile and arbitrary, as present circumstances are the result of fossil-fuel consuming societies. The discussion should instead focus on humans as agents on a geological scale (Edgeworth *et al.* 2019).

Traditional archaeological methods can observe aspects of the hyperobject, but increasingly, scientific methods reveal its effects (e.g. Waters *et al.* 2016). Hyperobjects "exert downward causal pressure on shorter-lived entities" (Morton 2013: 67), causing asymmetry, which, in the case of global warming, removes a level of agency from humans. In order to address the hyperobject's large-scale asymmetric effect upon us, ecofacts come to the forefront of inquiry, while artefacts recede.

Artefacts and features are material culture that include, but are not limited to, human-made objects, buildings and sites. In contrast, ecofacts are environmental indicators of human activity, including direct deposits such as anthropogenic sediments and indirect deposits like pollen, which are indicative of anthropogenic environmental change. Ecofacts have played an increased role in archaeological interpretations through geoarchaeology, palaeoethnobotany and ancient DNA analysis (e.g. Roberts *et al.* 2017; Rothacker *et al.* 2018). Identification of anthropogenic *terra preta* soils, for example, has revolutionised our understanding of prehistoric Amazonian land-use (Roberts *et al.* 2017). Meanwhile, Harper (2017: 15) has re-framed the Roman Empire through environmental data, arguing that the Romans "had no idea of the contingent and parlous environmental foundations of what they had built"; while elements of his synthesis have been criticised (Haldon *et al.* 2018), Harper's argument of contingent existence based on factors of vast timescales is accepted. Rather than through artefacts, these large-scale narratives are therefore evident through ecofacts.

Artefacts cannot be separated into their components without losing their function. Normark (2014), however, has coined the term *hyperfact* to describe entities that exist in multiple forms while maintaining their essence. Water is used by humans in many ways, yet it maintains its essence, making it neither cultural nor natural (Normark 2014: 189). The Anthropocene introduces several entities that do not easily fit within our conventional archaeological categories; hyperfact is one such new category. Radioactivity, for example, cannot be directly observed and exists on different scales, which better fits the category of hyperfact than artefact or ecofact. As hyperfacts are used by humans while maintaining their essence, they possess lives beyond human use. The 'dark artefact' afterlives erupt out of human intentions into unexpected manifestations. This is especially evident with radiation (Hudson 2014: 84; Pétursdóttir 2017: 196). In this period of asymmetry, ecofacts, hyperfacts and dark artefacts allow for an understanding of Anthropocene cultures.

Finding cultural narratives in Anthropocene deposits

Future archaeologists will interpret cultural narratives from multi-scalar sources spanning from the molecular to planetary. This is not an imagined future; these are anthropogenic data that currently exist. At the smallest scale, synthetic elements—Periodic Table numbers 43, 61, 85, 87 and 93–115—do not occur naturally, but are used in medicine and technologies, such as smoke detectors (Stoker 2007: 275). Humans have modified DNA for millennia through domestication, including "all Linnaean animal classes—mammals, birds, reptiles, amphibians, fish, insects, and even, arguably, bacteria" (Zeder 2012: 161). Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) now even allows for direct—if illegal—gene editing of humans (Ran *et al.* 2013), with two children born recently in China being the first genetically modified humans (Zhang 2019). Anthropogenic climate change is also

affecting the DNA of species through temperature change, ecosystem stresses and increased UV radiation (Caldwell *et al.* 2007).

The splitting of the atom is a defining scientific advancement of the modern era and its most distinctive indicator is the global radiation layer that appeared in the 1950s (Waters *et al.* 2016). Radiation from early atomic testing has permeated everything, increasing radioactivity in terrestrial metals and within the teeth of individuals born after 1945 (Spalding *et al.* 2005; Holmes *et al.* 2017: 1). Anthropogenic radiation is not a material, yet it has agency that shapes policy, architecture and clothing. It is a product of energy creation, only perceptible as heat or through instrumentation, and it has profound effects. The 1986 Chernobyl meltdown created a radiation zone that is still causing biological mutations (Møller & Mousseau 2006). Sponge divers believe that Chernobyl caused the Mediterranean sponge blight (Kalafatas 2003: 52), permanently ending highly developed, insular cultures in a single summer. This radioactive waste has a half-life of 250 000 years, yet the entirety of anatomically modern humans' existence is only approximately 200 000 years old. This raises the question of what our species will be when the waste is finally inert.

In the future, a Geiger counter may become as common as a trowel for Anthropocene archaeologists (Figure 1). The global radiation layer creates a temporal, stratigraphic divide (Spalding *et al.* 2005), similar to the KT boundary in palaeontology. A site anywhere in the world can be temporally oriented based on its position relative to this radiation layer.

Figure 1. A dosimetrist checks radioactivity with a Geiger counter while wearing field gear that may become common for Anthropocene archaeologists (Presslab/Shutterstock).

Global chemical signatures from pesticides, leaded petrol and fertiliser serve as similar stratigraphic boundaries (Waters *et al.* 2016: 137).

Five extinction events over the course of Earth's history eliminated >75 per cent of species (Ceballos *et al.* 2015). A 'sixth extinction' is underway, based on a vertebrate extinction rate that is 100 times higher than the baseline (Ceballos *et al.* 2015). Similar to the extinction horizon observed for Pleistocene megafauna, future archaeologists may observe a horizon separating Holocene layers with wild mammals from Anthropocene layers missing. Instead, a preponderance of domesticated species will be evident. Human biomass, together with our domesticated species, currently outweighs twenty-fold the combined biomass of all mammals in nature (Bar-On *et al.* 2018). Given preservation rates, we may pass the threshold of 'wild' species being visible in the palaeontological record.

Human activity has given rise to serious ecological issues, with implications for ourselves as well as other species. Irregular and extreme weather events caused by climate change, for example, are amplifying droughts (Figure 2)—a significant contributing factor to the Syrian civil war and subsequent mass migration from the country (Gleick 2014). There is uncertainty whether crops can adapt to temperature changes (Gregory *et al.* 2005: 2145). Ecologists have confronted an uncomfortable truth that there is no 'nature' remaining: "Nature is simply reified history", argues Morton (2013: 58). National parks are viewed as 'nature', but they are culturally manufactured to fit an interpretation of 'nature' prior to modern humans (Angermeier 1994). Pritchard (2002) demonstrates that the environments and species found in Yellowstone National Park reflected the human managers' perception of 'natural Yellowstone', rather than any objective nature. Indeed, most national parks maintain a reified and static 'nature' through a strategy of culling certain species while bolstering others (Angermeier 1994; Morton 2007: 164). Moreover, post-human landscapes do not return to a primordial state. Instead, new plants develop over abandoned sites (e.g. Mathews 2017), indicating buried human strata (Parcak 2009: 92). While an abandoned cultural landscape can become a non-human landscape, it never returns to its pre-human form.

Materials have been crucial in understanding past cultures, whether stone, bronze or iron. Childe (1929: v–vi), for example, stated that

> *We find certain types of remains—pots, implements, ornaments, burial rites, house forms —constantly recurring together. Such a complex of regularly associated traits we shall term a 'cultural group' or just a 'culture'. We assume that such a complex is the material expression of what today would be called a people.*

Yet, such materials may be less useful to future archaeologists. Mass production creates enormous quantities of goods that are transported globally, resulting in artefacts with less meaningful connections to individuals or place. Today, the presence of Ikea furniture, Walmart dishes and Styrofoam cups designed for disposability reveal less about any individual culture. Miller (2010: 9) correctly argues that even mass-produced goods have different meanings based on context. The objects, however, will probably generate less meaning for future archaeologists than other sources, such as digital data.

Computers are integral to many contemporary cultures for communication, information storage and mechanised labour. A decade ago, a computer was a standalone, contained

Figure 2. Anthropocene environmental crises include drought, such as in the Aral Sea (top), and increased extreme weather events, such as Hurricane Harvey (bottom) (Daniel Prudek/Shutterstock; MDay Photography/Shutterstock).

technology, but the Internet of Things has integrated everyday objects into computer networks, and 2.5 quintillion bytes of data are generated each day (Marr 2018: 1). An understanding of contemporary culture is impossible without reference to digital data or the Internet (Aycock in press).

The study of an ancient artefact typically consists of describing its outward characteristics and context: its design, materials, shape and spatial location on-site, and cultural significance. In addition, inward examination of an artefact, such as petrology or isotope analysis, provides

supplementary data to the context. Although an artefact's inward data are limited, digital data are the opposite. Computers can be the same model, but the data stored within may differ considerably. We cannot engage with the vast quantities of digital data in the same way that we can with historical archaeology, where textual accounts supplement archaeological evidence. Rather, digital data are primary, formative and the drivers of culture and cultural identity (e.g. Reinhard 2018). There is, however, mounting concern of a 'Digital Dark Age' as degrading compact discs, hard drives and file formats cause data to disappear from the digital-historical record (Jeffrey 2012: 554). Despite the enormous amount of data created, less information may survive from the present than from earlier periods.

Anthropogenic greenhouse gases are global in scale. CO_2 is higher now than in any period in the last three million years (Waters *et al.* 2016). Chlorofluorocarbons have degraded the ozone layer (Figure 3), increasing UV radiation and causing genetic mutations (Kelfkens *et al.* 1990). Global warming is physically altering the seafloor and glaciers are receding (Sulpis *et al.* 2018). This will result in sea-level rise, affecting coastal settlements (Nicholls & Cazenave 2010). Oceans, which cover 70 per cent of the planet, have borne the majority of the impact of this anthropogenic activity, for example, through microplastics (Cole *et al.* 2011). Waste has collected in oceanic gyres. The 'Great Garbage Patch' in the Pacific Ocean measures over 1.6 million km^2 and is composed of ~1.8 trillion plastic pieces (Lebreton *et al.* 2018). In terms of surface area, it is the planet's largest cultural deposit, even though located 1600km from land.

The long-term impact of the anthropogenic hyperobject is measured in centuries and millennia. Seventy-five per cent of the effects of global warming will persist for 500 years—and 7 per cent for 100 000 years (Morton 2013: 58–59). It will shape the social, political and cultural development of our species. Historically disenfranchised groups will bear the brunt of social and economic burdens, while developing countries will fall further behind industrialised leaders. Ironically, the latter have disproportionally contributed to the hyperobject. These changes are certain to leave an imprint in the archaeological record. The hyperobject affects the existing archaeological record through capitalism's market for certain artefacts, driving widespread and systematic looting of archaeological sites (Campbell 2013). Anthropocene archaeologists may therefore struggle to find undisturbed contexts.

The human residue extends beyond the Earth's bounds. There are orbiting satellites, space stations and debris from hundreds of launches since 1957, while material from NASA's missions remain on Mars and the Moon (Gorman 2014; O'Leary & Capelotti 2015). Researchers have begun examining the archaeology of the International Space Station (Walsh & Gorman 2021). The Voyager 1 satellite has travelled 21 billion kilometres, leaving our solar system for interstellar space. The most significant cultural assemblage in space, however, may be radiowaves. Travelling 100 light years from Earth—28 000 times further than Voyager 1—one could listen to our earliest radio transmissions (Bennett 2017). It is through radiowaves that humans may contribute something to deep time, far outlasting physical structures.

Discussion

The Anthropocene is not defined simply by human impact on the environment, but also by the unintended creation of a hyperobject that is changing the climate through the persistence

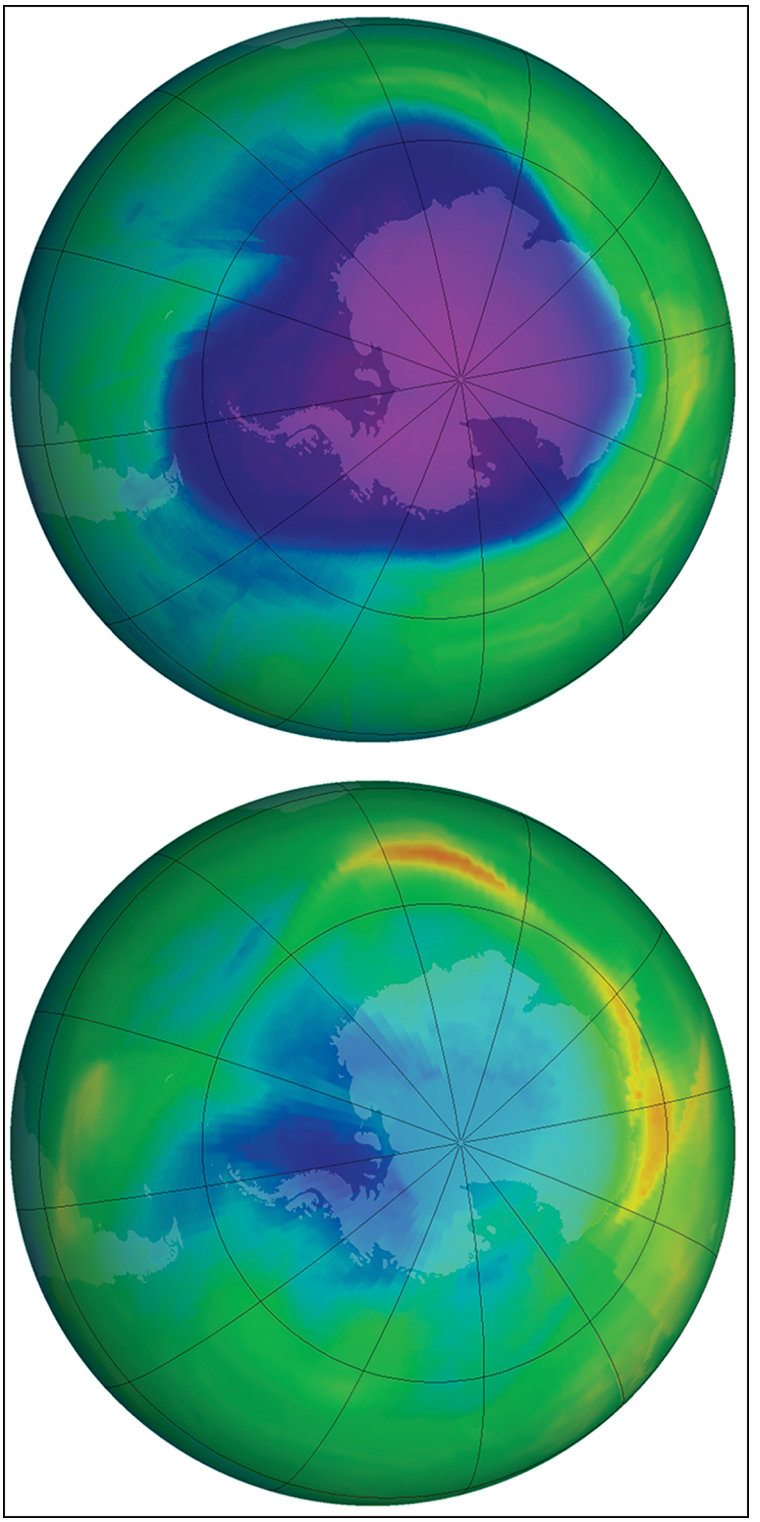

Figure 3. The depletion of the ozone layer over Antarctica from 1979–2008 is evident through scientific instrumentation, but it is not directly observable (NASA/Goddard Space Flight Center/Ozone Processing Team).

of objects. Inside the hyperobject, archaeology ceases to be bounded in the conventional manner. Pétursdóttir (2017: 196) argues that "Traditionally, *meaning* in archaeology is constructed through the inherent, hierarchical ordering of archaeological assemblages confined to certain localities, and relations between these", but Anthropocene objects extend beyond these bounds. While we may be able to observe a Palaeolithic stone tool from the outside, the layer of radiation blanketing the planet interacts with our very tissues. It is part of us. This archaeology cannot be addressed through processual or post-processual paradigms. Anthropocene archaeology is altogether different and requires new approaches, such as symmetrical archaeology, new materialism, supermodernity and others (Witmore 2007; Dawdy 2009; Olivier 2011; Olsen *et al.* 2012; Edgeworth 2016; Harrison 2016; Pétursdóttir 2017; González-Ruibal 2019).

The narrative of contemporary societies cannot be told without the splitting of the atom, the Internet and anthropogenic climate change. Arguably, our present material record makes no sense without non-material sources: radiation and radio waves are not *material* culture, but are cultural, durable and provide significant information (Figure 4). Just as physicists measure gravity waves as the archaeo-energy of the Big Bang, archaeology will use energy sources to learn about cultures. These new sources are dark artefacts, which are strange and distant from what we currently consider archaeology to be. The Anthropocene archaeologist, however, will likely be well versed in them. Physically bounded flat 'containers', such as artefacts, sites, features and assemblages (Table 1), are giving way to unbounded dark objects erupting with unintended and persistent qualities: archaeo-energy, hyperfacts, digital-facts and ecofacts.

Traditional definitions of archaeology were designed for a field that is now in the past. Already, looters are targeting ships sunk during the World Wars because pre-atomic steel has lower background radiation (Holmes *et al.* 2017: 1). This is a phenomenon unique to the Anthropocene: the value is neither intrinsic nor aesthetic, but due to the fact that it is less Anthropocenic than metal found on land. Murder investigators distinguish unidentified victims born after 1945 from the radiation in their teeth (Spalding *et al.* 2005). An excavation on the University of California at Davis campus revealed dogs encased in concrete that remain radioactive after death due to medical experiments with strontium-90 and radium-226 (Morton 2013: 34). This is the nature of archaeology in a field reshaped to teach the lessons of an Anthropocene rather than Holocene Earth. Can a 'deposit' be in the atmosphere or space? Is it a 'site' if travelling at 27 500km per hour around the planet? Traditional archaeology becomes problematic upon entering the Anthropocene: we must define archaeology for a future of sequencing DNA, collecting microplastics and detecting radioactivity.

Defining archaeology for the future past

The challenge of the Anthropocene necessitates a "jolting of the archaeological imagination" (Pétursdóttir 2017: 192). The definition of archaeology might be different for our future colleagues. The etymology of the term is Greek—*archaiologia* is derived from a combination of *archaios* (ancient or old) and *logia* (study or learning). Most 'ancient or old' objects survive as part of the material record, which is a significant component of most definitions:

Figure 4. Archaeo-energy contains cultural information, such as the global radiation layer and radio waves (Lukasz Pawel Szczepanski/Shutterstock; Vchal/Shutterstock).

Table 1. Conventional, bounded, categories of archaeological data compared with unbounded categories.

Bounded categories	Examples	Unbounded categories	Examples
Artefact	Handaxe; Rosetta Stone	*Ecofact*	Anthropogenic sediments; greenhouse gases; DNA; microplastics
Site	Settlement; Stonehenge	*Hyperfact*	Water; radioactivity
Feature	Grave; posthole	*Archaeo-energy*	Radio waves; nuclear radiation
Assemblage	A site's lithics collection; Athenian *ostraka*	*Digital-fact*	ASCII data; Geocities archive; mp3 file; online communities

"Archaeology is basically about three things: objects, landscapes and what we make of them. It is quite simply the study of the past through material remains" (Gamble 2000: 15). The current definitions of archaeology are designed for hearths and handaxes. A definition encompassing the entirety of human residue would be more helpful.

The concept of 'old' is problematic and limiting (Nativ & Lucas 2020). Shanks (1995: 17) argues that archaeology "focuses upon the gap between the lived past and its ruin now". Consideration of our Anthropocene future could be seen as pondering the gap between the lived present and ruined future. This is because of the persistence and monstrosity of Anthropocene objects, which continue beyond human control and lifetimes (Pétursdóttir 2017; Witmore 2019). Their persistence precludes a gap (Hudson 2014: 85; Nativ & Lucas 2020: 853): we are integrated into the objects' present and future. Global warming and radioactive waste were produced in the past, and indeed in the present, but their agency extends into the future. The Human Interference Task Force's study of radioactive waste facilities required imagining distant futures, such that their Waste Isolation Pilot Plant, for example, includes warnings designed to communicate without the English language and with very different or non-humans in mind (Trauth *et al.* 1993). Archaeology, then, becomes the study of human cultures across time, examining past and future objects. This is not philosophical, but methodological. The study of past plastics must include present humans contaminated with mercury (Hudson 2014: 83) and the study of Lucca's present forest in Italy is the study of past agriculture that reshaped the landscape and the species inhabiting it (Mathews 2017: G145).

What is it we are doing as archaeologists? Are we focused solely on material culture? Hodder (2012: 218) acknowledges archaeology's material bias, stating that "things are really flows of matter, energy and information but I have focused largely on those flows that produce hard matter that endures", while "gases, vapors, smells and sounds" do not receive much attention. It is not that archaeologists fail to understand the significance of the immaterial, but rather that they have difficulty addressing these entities methodologically. Archaeology is therefore the study of culture, with the material record offering the best source to understand life during the Pleistocene and Holocene. This may not be the case for the Anthropocene.

More idealised definitions of archaeology get to the heart of the matter. Schiffer (1999: 64) states that "Anthropology is the only discipline that can access evidence about the entire human experience on this planet", while Hurst Thomas (1989: 31) argues that "It's not what you find, it's what you find out". If archaeology's aim is to understand the human experience, then material culture is simply one vector through which to do so. A definition must reflect the diversity of cultural information available (Witmore 2014; Pétursdóttir 2017), including radiation and atmospheric CO_2. These material and immaterial entities distinguish the Anthropocene from the Holocene and form the core of study for the future archaeologist. Hence, archaeology examines the sum of human residue and its persistence on Earth and beyond.

Conclusion

Archaeology is expanding beyond the material record and, arguably, the study of the past. Human residue cannot be regarded as comprising spatially and temporally flat 'containers': that is, the tangible objects denoted by the term 'artefact'; ecofacts are increasingly significant for identifying large-scale narratives. Cultural evidence is simultaneously both miniscule, existing at a molecular level, and immense, expanding hundreds of light years beyond our planet. It includes radiation, radio waves and greenhouse gases. Humans have created a hyperobject—whether known as the archaeological record, archaeosphere or hypanthropos—of vast timescales that will remain for hundreds of thousands of years. As Nativ and Lucas (2020) argue for historical continuity in archaeology, exposing the false past/present dichotomy, the field must also confront its object- and surface-based worldview. Anthropocene archaeology begins when archaeologists seek cultural meaning from archaeo-energy or sites in space; the definition needs to expand, however, to allow conceptual space for new theories and methodologies.

Acknowledgements

I would like to thank Sara Rich and Martina Caruso for numerous discussions. This article drew inspiration from Matt Edgeworth, Alice Gorman, Johan Normark, Bjørnar Olsen, Þóra Pétursdóttir, Christopher Witmore and others. I extend my gratitude to the anonymous reviewers whose comments improved the article.

Funding statement

This research received no specific grant from any funding agency or from commercial and not-for-profit sectors.

References

Angermeier, P.L. 1994. Does biodiversity include artificial diversity? *Conservation Biology* 8: 600–602. https://doi.org/10.1046/j.1523-1739.1994.08020600.x

Aycock, J. In press. The coming tsunami of digital artefacts. *Antiquity* 95. https://doi.org/10.15184/aqy.2021.84

Bar-On, Y.M., R. Phillips & R. Milo. 2018. The biomass distribution on Earth. *Proceedings of the*

National Academy of Sciences of the USA 115: 6506–11. https://doi.org/10.1073/pnas.1711842115

Bennett, J. 2017. Galactic map of every human radio broadcast reveals how isolated we are. *Popular Mechanics*, 25 August. Available at: https://www.popularmechanics.com/space/news/a27934/galaxy-map-human-radio-broadcasts (accessed 7 December 2020).

Binford, L.R. 1964. A consideration of archaeological research design. *American Antiquity* 29: 425–41. https://doi.org/10.2307/277978

Caldwell, M.M. *et al.* 2007. Terrestrial ecosystems, increased solar ultraviolet radiation, and interactions with other climate change factors. *Photochemical & Photobiological Sciences* 6: 252–66. https://doi.org/10.1039/b700019g

Campbell, P.B. 2013. The illicit antiquities trade as a transnational criminal network. *International Journal of Cultural Property* 20: 113–53. https://doi.org/10.1017/S0940739113000015

Ceballos, G. *et al.* 2015. Accelerated modern human-induced species losses: entering the sixth mass extinction. *Science Advances* 1: e1400253. https://doi.org/10.1126/sciadv.1400253

Childe, V.G. 1929. *The Danube in prehistory*. Oxford: Oxford University Press.

Cole, M., P. Lindeque, C. Halsband & T.S. Galloway. 2011. Microplastics as contaminants in the marine environment: a review. *Marine Pollution Bulletin* 62: 2588–97. https://doi.org/10.1016/j.marpolbul.2011.09.025

Crutzen, P.J. 2002. Geology of mankind. *Nature* 415: 23. https://doi.org/10.1038/415023a

Dawdy, S. 2009. Millennial archaeology: locating the discipline in the age of insecurity. *Archaeological Dialogues* 16: 131–42. https://doi.org/10.1017/S1380203809990055

Edgeworth, M. 2016. Grounded objects: archaeology and speculative realism. *Archaeological Dialogues* 23: 93–113. https://doi.org/10.1017/S138020381600012X

– 2018. More than just a record: active ecological effects of archaeological strata, in M.A.T. de Souza & D.M. Costa (ed.) *Historical archaeology and environment*: 19–40. Cham: Springer.

Egdeworth, M. *et al.* 2019. The chronostratigraphic method is unsuitable for determining the start of the Anthropocene. *Progress in Physical Geography* 43: 334–44. https://doi.org/10.1177/0309133319831673

Gamble, C. 2000. *Archaeology: the basics*. London: Routledge.

Gleick, P.H. 2014. Water, drought, climate change, and conflict in Syria. *Weather, Climate, and Society* 6: 331–40. https://doi.org/10.1175/WCAS-D-13-00059.1

González-Ruibal, A. 2019. *An archaeology of the contemporary era*. London: Routledge. https://doi.org/10.4324/9780429441752

Gorman, A. 2014. The Anthropocene in the solar system. *Journal of Contemporary Archaeology* 1: 87–91. https://doi.org/10.1558/jca.v1i1.87

Gregory, P.J., J.S.I. Ingram & M. Brklacich. 2005. Climate change and food security. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences* 360: 2139–48. https://doi.org/10.1098/rstb.2005.1745

Haldon, J. *et al.* 2018. Plagues, climate change, and the end of an empire: a response to Kyle Harper's *The fate of Rome* (1): climate. *History Compass* 16: e12508. https://doi.org/10.1111/hic3.12508

Harman, G. 2018. *Object-oriented ontology: a new theory of everything*. London: Penguin. https://doi.org/10.1093/acrefore/9780190201098.013.997

Harper, K. 2017. *The fate of Rome: climate, disease, and the end of an empire*. Princeton (NJ): Princeton University Press. https://doi.org/10.2307/j.ctv9b2txr

Harrison, R. 2016. Archaeologies of emergent presents and futures. *Historical Archaeology* 50: 165–80. https://doi.org/10.1007/BF03377340

Hodder, I. 2012. *Entangled: an archaeology of the relationships between humans and things*. Oxford: Wiley-Blackwell. https://doi.org/10.1002/9781118241912

Holmes, O., M. Ulmanu & S. Roberts. 2017. The world's biggest grave robbery: Asia's disappearing WWII shipwrecks. *The Guardian*, 3 November. Available at: https://www.theguardian.com/world/ng-interactive/2017/nov/03/worlds-biggest-grave-robbery-asias-disappearing-ww2-shipwrecks (accessed 7 December 2020).

Hudson, M.J. 2014. Dark artifacts: hyperobjects and the archaeology of the Anthropocene. *Journal of Contemporary Archaeology* 1: 82–86. https://doi.org/10.1558/jca.v1i1.82

Jeffrey, S. 2012. A new digital dark age? Collaborative web tools, social media and long-term preservation. *World Archaeology* 44: 553–70. https://doi.org/10.1080/00438243.2012.737579

Kalafatas, M.N. 2003. *The Bellstone: the Greek sponge divers of the Aegean*. Hanover: Brandeis University Press. https://doi.org/10.26812/9781584652724

Kelfkens, G., F.R. de Gruijl & J.C. van der Leun. 1990. Ozone depletion and increase in annual carcinogenic ultraviolet dose. *Photochemistry and Photobiology* 52: 819–23. https://doi.org/10.1111/j.1751-1097.1990.tb08687.x

Lebreton, L. *et al*. 2018. Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic. *Scientific Reports* 8: 4666. https://doi.org/10.1038/s41598-018-22939-w

Marr, B. 2018. How much data do we create every day? The mind-blowing stats everyone should read. *Forbes*, 21 May. Available at: https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/?sh=149d091860ba (accessed 7 December 2020).

Mathews, A.S. 2017. Ghostly forms and forest histories, in A. Tsing, H. Swanson, E. Gan & N. Bubandt (ed.) *Arts of living on a damaged planet*: 145–56. Minneapolis: University of Minnesota Press.

Miller, D. 2010. *Stuff*. Cambridge: Polity.

Møller, A.P. & T.A. Mousseau. 2006. Biological consequences of Chernobyl: 20 years on. *Trends in Ecology & Evolution* 21: 200–207. https://doi.org/10.1016/j.tree.2006.01.008

Morton, T. 2007. *Ecology without nature*. Cambridge (MA): Harvard University Press.

– 2013. *Hyperobjects: philosophy and ecology after the end of the world*. New York: Columbia University Press.

Nativ, A. & G. Lucas. 2020. Archaeology without antiquity. *Antiquity* 94: 852–63. https://doi.org/10.15184/aqy.2020.90

Nicholls, R.J. & A. Cazenave. 2010. Sea-level rise and its impact on coastal zones. *Science* 328: 1517–20. https://doi.org/10.1126/science.1185782

Normark, J. 2014. Water as a hyperfact. *Current Swedish Archaeology* 22: 183–206.

O'Leary, B.L. & P.J. Capelotti. 2015. *Archaeology and heritage of the human movement into space*. New York: Springer. https://doi.org/10.1007/978-3-319-07866-3

Olivier, L. 2011. *The dark abyss of time: memory and archaeology*. Lanham (MD): AltaMira.

Olsen, B., M. Shanks, T. Webmoor & C. Witmore. 2012. *Archaeology: the discipline of things*. Berkeley: University of California Press. https://doi.org/10.1525/9780520954007

Parcak, S.H. 2009. *Satellite remote sensing for archaeology*. New York: Routledge. https://doi.org/10.4324/9780203881460

Pétursdóttir, Þ. 2017. Climate change? Archaeology and Anthropocene. *Archaeological Dialogues* 24: 175–205. https://doi.org/10.1017/S1380203817000216

Pritchard, J.A. 2002. The meaning of nature: wilderness, wildlife, and ecological values in the national parks. *The George Wright Forum* 19: 46–56.

Ran, F.A. *et al*. 2013. Genome engineering using the CRISPR-Cas9 system. *Nature Protocols* 8: 2281. https://doi.org/10.1038/nprot.2013.143

Rao, K.R. 2001. Radioactive waste: the problem and its management. *Current Science* 81: 1534–46.

Reinhard, A. 2018. *Archaeogaming: an introduction to archaeology in and of video games*. New York: Berghahn. https://doi.org/10.2307/j.ctvw04bb5

Roberts, P. *et al*. 2017. The deep human prehistory of global tropical forests and its relevance for modern conservation. *Nature Plants* 3: 17093. https://doi.org/10.1038/nplants.2017.93

Rothacker, L. *et al*. 2018. Impact of climate change and human activity on soil landscapes over the past 12 300 years. *Scientific Reports* 8: 247. https://doi.org/10.1038/s41598-017-18603-4

Schiffer, M.B. 1999. Return to holism. *Anthropology News* 40: 64–65. https://doi.org/10.1111/an.1999.40.7.64

Scott, J.C. 2017. *Against the grain: a deep history of the earliest states*. New Haven (CT): Yale University Press. https://doi.org/10.2307/j.ctv1bvnfk9

Shanks, M. 1995. Archaeological realities: embodiment and a critical romanticism, in M. Tusa & T. Kirkinen (ed.) *The archaeologist and their reality: proceedings of the 4th Nordic TAG conference*: 1–30. Helsinki: University of Helsinki.

Spalding, K.L. *et al*. 2005. Age written in teeth by nuclear tests. *Nature* 437: 333–34. https://doi.org/10.1038/437333a

Steffen, W. *et al.* 2015. The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review* 2: 81–98. https://doi.org/10.1177/2053019614564785

Stoker, H.S. 2007. *General, organic, and biological chemistry*. New York: Houghton Mifflin.

Sulpis, O. *et al.* 2018. Current $CaCO_3$ dissolution at the seafloor caused by anthropogenic CO_2. *Proceedings of the National Academy of Sciences of the USA* 115: 11700–705. https://doi.org/10.1073/pnas.1804250115

Thomas, D.H. 1989. *Archaeology*. Fort Worth (TX): Holt, Rinehardt & Winston.

Trauth, K.M., S.C. Hora & R.V. Guzowski. 1993. *Expert judgment on markers to deter inadvertent human intrusion into the waste isolation pilot plant*. Washington, D.C.: U.S. Department of Energy. https://doi.org/10.2172/10117359

Walsh, J. St P. & A. Gorman. 2021. A method for space archaeology research: The International Space Station Archaeological Project. *Antiquity* 95: 1315–1327. https://doi.org/10.15184/aqy.2021.114

Waters, C.N. *et al.* 2016. The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science* 351: 10.1126. https://doi.org/10.1126/science.aad2622

Witmore, C. 2007. Symmetrical archaeology: excerpts of a manifesto. *World Archaeology* 39: 546–62. https://doi.org/10.1080/00438240701679411

– 2014. Archaeology, the Anthropocene, and the hypanthropocene. *Journal of Contemporary Archaeology* 1: 128–32. https://doi.org/10.1558/jca.v1i1.128

– 2019. Hypanthropos: on apprehending and approaching that which is in excess of monstrosity, with special consideration given to the photography of Edward Burtynsky. *Journal of Contemporary Archaeology* 6: 136–53. https://doi.org/10.1558/jca.33819

Zeder, M.A. 2012. The domestication of animals. *Journal of Anthropological Research* 68: 161–90. https://doi.org/10.3998/jar.0521004.0068.201

Zhang, P. 2019. China confirms birth of gene-edited babies, blames scientist He Jiankui for breaking rules. *South China Morning Post*, 21 January. Available at: https://www.scmp.com/news/china/science/article/2182964/china-confirms-gene-edited-babies-blames-scientist-he-jiankui (accessed 7 December 2020).