



**HAL**  
open science

## Dating Debate

Nathanaël Wallenhorst

► **To cite this version:**

Nathanaël Wallenhorst. Dating Debate. Handbook of the Anthropocene, Springer International Publishing, pp.349-357, 2023, <10.1007/978-3-031-25910-4\_53>. <halshs-04251694>

**HAL Id: halshs-04251694**

**<https://shs.hal.science/halshs-04251694v1>**

Submitted on 26 Oct 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

## Dating debate

**Nathanaël Wallenhorst<sup>1</sup>**

**Abstract** This notice provides in-depth insight into the debate (based on stratigraphic findings) as to the exact date that Earth entered the Anthropocene Epoch. Generally, in Human and Social Sciences, the date of the boundary is paid less attention than the systemic shifts resulting from it. (There have been a number of publications on our surpassing of the planet's limits, and passing of the point of no return). This article explores each of the possible dates when stratigraphic data suggest the Anthropocene may begun. We propose a synthesis of the seven main possible dates for the entry into the Anthropocene.

### *Hypothesis 1: 400,000 years ago, with the mastery of fire*

The earliest proposed date for the dawn of the Anthropocene is in the Stone Age<sup>6</sup> (Doughty, 2013). The frequent use of fire in the late Pleistocene, around 400,000 years in Africa, is certainly the first way in which humans made a mark on their environment (Roebroeks and Villa, 2011). However, as the use of fire is always local, it does not give rise to a GSSP (global), and therefore cannot be used to mark the boundary (Lewis and Maslin, 2015, p. 173). Another event which indelibly marked the biosphere was the megafauna extinction, with half of large mammal species dying out. However, this event (between 50,000 and 12,000 years ago) cannot be used as a GSSP either, because the extinction was very uneven from one continent to another, and took place at different times (Lewis and Maslin, 2015, p. 174).

### *Hypothesis 2: between 8,000 and 5,000 years ago, with the development of agriculture*

A number of authors, such as American science journalist Michael Balter (2013), American-Belgian ecologist Jed O. Kaplan *et al.* (2011) and American palaeoclimatologist William F. Ruddiman (2003; 2013; Ruddiman *et al.*, 2014), believe the Anthropocene began with the development of agriculture and the resulting alteration of the atmosphere's chemical composition. As the climate stabilised at the dawn of the Holocene, agriculture was able to develop in various locations across the globe. It began continents some 10,000 years ago, in southeast Asia, northern China and South America (Lewis and Maslin, 2015, p. 174). Over time, agriculture led to natural vegetation being replaced by crop species. It also drove certain animal species to extinction, in favour of others which could be domesticated. Agriculture also altered the flow of biogeochemicals. Indeed, drawn from Lewis and Maslin (2015, p. 174), the atmospheric peak of methane (CH<sub>4</sub>) in 5020 BP ('before present', with 'present' taken to be 1950) recorded in ice cores could represent a GSSP, because it may be due to rice agriculture in Asia and growing numbers of ruminants.<sup>7</sup>

The hypothesis of an 'early Anthropocene' is supported by a number of findings: the alteration of the terrestrial habitat and terrestrial biotic shifts, microbiotic changes in the ocean and shifts

---

<sup>1</sup> N. Wallenhorst  
Catholic University of the West  
Angers, France  
nathanael.wallenhorst@uco.fr

in the makeup of the atmosphere, caused by agriculture (Zalasiewicz *et al.*, 2014). Conceivably, the development of agriculture may have helped maintain the warmer temperatures of the Holocene, preventing a new Ice Age. For example, we see a spike in CO<sub>2</sub> levels 8,000 years ago, and a similar one for methane 5,000 years ago (MacFarling Meure *et al.*, 2006). However, this hypothesis has yet to be fully confirmed. The unusually long interglacial period we are currently experiencing could also be due to non-anthropogenic changes in solar radiation and shifts in Earth's orbit<sup>8</sup>, altering methane emissions in humid tropical zones (Steffen *et al.*, 2011a, p. 847; Lewis and Maslin, 2015, p. 174).

Two authors (Certini and Scalenghe, 2011) propose to date the start of the Anthropocene at 2,000 years ago. This does not correspond exactly to the development of agriculture, but to the development of large civilisations which have left traces in soil cores. They consider the paedosphere (soil free from ice) to be 'the best indicator of the increasing human impact on the whole of the environment come up because it strongly reflects the increasing impact of the earliest civilisation on a large portion of the Earth's surface' (2011, p. 1269). Finally, they believe soil is a better stratigraphic indicator than atmospheric chemical alterations, in determining where to place a golden spike. Soils have undergone numerous modifications as the result of human activity, to fertilise crops. However, their proposal falls down, as they view the Anthropocene as the anthropisation of the planet, whereas in fact, the term refers to the wholesale alteration of Earth's system.

### *Hypothesis 3: 1610, when the Old World met the New*

Another event could come into play in defining the start of the Anthropocene – what Lewis and Maslin (2015) term the collision between the Old and the New World. To date, they are the only researchers to have suggested this as a GSSP. This event marks the start of organised human society all over the world, with shared food products, reshaping both plant and animal life. Above all, Europeans' arrival in America in 1492 heralded a sharp decline in world population. In 1492, America's population was estimated at between 54 and 61 million. Only 158 years later, in 1650, it had fallen to 6 million. This population slump in America was due to war, slavery, disease brought by Europeans, and famine. This marked decrease in human population led to a reduction in farmland, and woodland began to recover, reaching an estimated 50 million hectares of forest. This decreased atmospheric CO<sub>2</sub> by 7-10 ppm, which can be seen in Antarctic sediment cores from between 1570 and 1620. Lewis and Maslin estimate 1610 as an appropriate GSSP marker. Secondary stratotypes are associated with this approximate date, such as contact between biotopes from the Old and the New World (the fossil record shows that maize was introduced to Europe around this time), or the eruption of Huaynaputina, which can be seen in sediments from both poles and from the tropics. We see a drop in atmospheric methane, and the spread of Arctic ice. Two different ice cores, taken from the Antarctic, show this 7-10 ppm reduction in atmospheric CO<sub>2</sub>, which exceeds the possible margin of error (between 1 and 2 ppm). In addition to being visible in the sediments and representing a promising potential GSSP, the meeting of the Old and New Worlds was a major event in human history, representing the start of globalisation – the true characteristic of the contemporary period.

One of the strengths of Lewis and Maslin's (2015) approach is that they analyse geological data, rather than human historical data. This is why the proposed GSSP is 1610, corresponding with the dip in atmospheric CO<sub>2</sub>, as opposed to 1492. They reject the other possible dates for the start of the Anthropocene, as they are not based on a global marker. In their view, this date is the most promising candidate for a GSSP, in view of the radical and global shift it marks. As

the meeting of Old and New Worlds also opened the door to the Industrial Revolution, the date is compatible with Crutzen and Stoermer's (2000) initial hypothesis.

#### *Hypothesis 4: 1769 or 1800, with the start of the Industrial Revolution*

In his earliest articles, Crutzen (Crutzen and Stoermer, 2000; Crutzen, 2002) aligns the onset of the Anthropocene with the Industrial Revolution. If asked for a specific date, he would choose 1769, which is when the steam engine was invented.<sup>9</sup> In the eyes of a group of researchers including Crutzen, industrial technologies are to blame for our entry into the Anthropocene (Steffen *et al.*, 2011a; Waters *et al.*, 2011; Zalasiewicz *et al.*, 2011). They also point out that the global effects of the Industrial Revolution on the environment have surpassed those of agriculture. In the view of Zalasiewicz *et al.* (2008), the April 1815 eruption of Mount Tambora, which caused a volcanic winter lasting a year in the northern hemisphere, could be a 'natural' stratigraphic marker for the onset of the Anthropocene, which corresponds to the dawn of the Industrial Revolution.

In recent years, there has been less focus on the Industrial Revolution as the leading candidate for the start of the Anthropocene, but when the concept was first proposed, it was the prime suspect. In 2007, Steffen, Crutzen and McNeil described the industrial era as the first stage of the Anthropocene. The Industrial Revolution began in Britain, with the invention of the steam engine (which emits CO<sub>2</sub> into the atmosphere). It truly transformed Britain in around 1850, and eventually spread to the rest of the world. The tricky aspect of using the Industrial Revolution as the proposed date of the onset of the Anthropocene is that it occurred at the beginning of the 18<sup>th</sup> Century in the United Kingdom; then, between 1820 and 1880, it took over the east coast of the United States and western Europe; and at the very end of the 18<sup>th</sup> Century, it conquered the rest of Europe and the USA. Other countries were not touched by the Industrial Revolution until the 20<sup>th</sup> Century. Steffen, Grinevald, Crutzen and McNeil, in a 2011 article, proposed that the Anthropocene should be treated as a new epoch, dating from around 1800, with the beginning of the Industrial Revolution. Their position on the matter shifted, and in 2014, all four signed an article proposing 1945 as the start date of the Anthropocene from a stratigraphic viewpoint, with the placement of a golden spike (Zalasiewicz *et al.*, 2014a). Steffen *et al.* (2011a) view atmospheric CO<sub>2</sub> concentration as a good indicator of the onset of the Anthropocene. However, this argument may be contested by certain stratigraphers paying close attention to the sediment record. In 1750, atmospheric CO<sub>2</sub> was 277 ppm; it rose to 279 ppm in 1775; then to 283 ppm in 1800; and to 284 ppm in 1825. These figures are within the range of variability determined for the Holocene – between 260 and 285 ppm. The maximum natural variation for the Holocene was reached in 1850, at 285 ppm; then by 1900, it had been substantially surpassed, at 296 ppm (Steffen *et al.*, 2011a, p. 848; Etheridge *et al.*, 1998; Kleinen *et al.*, 2010). In Lewis and Maslin's view, the trace metal pollution associated with the Industrial Revolution cannot be used as a GSSP, because it is local and diachronic (traces of the use of such metals can be seen between 8,000 BP and the Industrial Revolution) (2015, p. 175). Whilst a collection of markers can be found from 1800 in North America and northern Europe (including the rise in atmospheric CO<sub>2</sub> from the 19<sup>th</sup> Century onwards), none of them are clear indicators of a GSSP, in Lewis and Maslin's opinion.

#### *Hypothesis 5: 1950, with the start of the Great Acceleration*

Since the mid-20<sup>th</sup> Century, there has been a huge rise in world population. This is particularly true of urban population, which soared from 730 million in 1945 to 3.7 billion city dwellers in 2014 (Zalasiewicz *et al.*, 2014, p. 3). Though the term 'Great Acceleration' had not yet been

coined, in 2004, Steffen *et al.* presented the curves showing the phenomenon. Then, in 2007, applying the term, they presented further plots illustrating evolving human activity on the planet. The Great Acceleration refers to an upswing in the production of manmade sediments. A number of authors also believe it can serve as a relevant stratigraphic marker (Waters *et al.*, 2014; Holtgrieve *et al.*, 2011; Wolfe *et al.*, 2013; Zalasiewicz *et al.*, 2014a). Zalasiewicz *et al.* (2014a, p. 4) identify a set of possible stratigraphic markers pertaining to the Great Acceleration: the disruption of the nitrogen cycle with the development of the Haber–Bosch process; technofossils, plastic waste and aluminium spread across the globe; the explosion of human deposits in the ground; the enormous increase in concentration of pollutants linked to the development of industrial activity; the passing of a significant milestone in anthropogenic changes to the biosphere, with numerous species dying out; the acceleration of hydrocarbon consumption, leading to an increase in atmospheric CO<sub>2</sub>; fossil traces connected to oil drilling; oil spills in coastal areas; and the construction of massive dams, reclaiming land from river deltas.

When updating the graphs of the Great Acceleration, extending the plots to 2010, Steffen *et al.* (2015) took up the debate as to the date of onset of the Anthropocene. They state that the start of the Great Acceleration, in the 1950s, is the most promising candidate from the standpoint of Earth system science, as that is when the natural variability margins of the Holocene were surpassed, and evidence indicates that these disruptions of Earth's system were driven by human activity. From a strictly stratigraphic perspective, Zalasiewicz and Williams (2013) also view the Great Acceleration, of the 1950s, as the start of the Anthropocene.<sup>10</sup>

#### *Hypothesis 6: 1945 or 1964, with the denotation of nuclear bombs*

Another hypothesis that has been investigated as the possible start date of the Anthropocene is 16 July 1945 – the date of the world's first nuclear test (codenamed Trinity) at Alamogordo in New Mexico<sup>11</sup> – or the radioactivity peak seen some 20 years later. After this first explosion, other nuclear detonations followed at an average of one per 9.6 days until 1988, altering the chemical makeup of the atmosphere (Zalasiewicz *et al.*, 2014, p. 1). The radioactive peak can be seen in 1964, just after the implementation of the Partial Nuclear-Test-Ban Treaty, signed in Moscow on 5 August 1963. Lewis and Maslin (2015) and Masco (2010) regard the atomic explosions as a sensible point at which to situate the onset of the Anthropocene, and the atmospheric radiocarbon ( $\Delta^{14}\text{C}$ ) peak provides an unambiguous GSSP.<sup>12</sup> For this reason, they propose the 1964 peak as a possible GSSP to date the planet's entry into the Anthropocene. Lewis and Maslin (2015) propose to use a pine tree, 25 km east of Kraków in Poland, whose growth rings show a radiocarbon spike, as the GSSP. The advantage of Lewis and Maslin's proposed GSSP in 1964 is the same as for the proposal of 1610. Their findings are based on stratigraphic data, rather than on human history (though the stratigraphic data directly reflect human history, with a lag of a few years or decades). The benefit of choosing 1964 as the start date for the Anthropocene is that it connects to a set of markers showing human impact on Earth's system, which can be seen in the course of the Great Acceleration. On the other hand, whilst the nuclear explosions did leave a mark in the stratigraphic record, they did not radically alter the Earth system (though the power they unleashed would have had the potential to do so). The proposed date is approximately the same as the start of the Great Acceleration, but we wish to draw a distinction between the two events (which not all authors do). The atomic bomb detonations do not correspond to the acceleration of consumption and industrial production, but to the crossing of a techno-scientific threshold directly linked to humanity's capacity for self-destruction.

Crutzen gradually revised his proposal on the date of the onset of the Anthropocene. Originally, he situated it alongside the invention of the steam engine, giving the approximate date of 1800, with the start of the Industrial Revolution in Britain. He later joined other researchers in proposing the first nuclear bomb detonation as a GSSP, on the basis of more solid stratigraphic evidence.

Zalasiewicz *et al.* (2014a, p. 6), in an article entitled ‘When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal’, specify that the significance of the Anthropocene lies in the ‘finding of the earliest traces of human impact on the Earth system, and the extent and longevity of the anthropic changes made to the Earth system’. For this reason, they propose a GSSA (Global Standard Stratigraphic Age) rather than a GSSP, situating the dawn of the Anthropocene in 1945, with the Alamogordo nuclear test. The strength of this approach is that it opens the door to multidisciplinary research on the Anthropocene, rather than confining it to geology. Their argument seems meritorious, and unusual for geologists and Earth system scientists, who make up the majority of the article’s 26 signatories.

The main advantage of using the fallout from nuclear bombs, from a stratigraphic point of view, is that it offers a clear, precipitous and widespread signature – and stratigraphers value signals such as this very highly (Waters *et al.*, 2015).

#### *Hypothesis 7: somewhere in the future*

For Wolfe (2014), there can be no doubt that human activity has altered elements of the Earth system; the traces can clearly be seen in ice cores from the ice caps – the glaciers covering the poles which are particularly important for climate stability.<sup>13</sup> However, he feels the human impact currently visible on the ice caps is not sufficient to mark a new geological boundary between the Holocene and the Anthropocene, because the change so far could, potentially, be reversible within the next 10,000 to 100,000 years. He does believe, however, that human activity is likely to delay the next glacial formation by at least 100,000 years. Wolfe (2014) recognises the significant – and global – anthropogenic traces left by nuclear explosions. Whilst Wolfe is very reserved and conservative in his reasoning, he believes that a GSSP could be placed in the ice in Greenland or the Antarctic, but is aware that it is not ideal from a stratigraphic standpoint, given the impermanence of the ice caps. For Wolfe (2014), it is evident that human beings have altered large parts of the Earth system. However, as it is not yet clear exactly what the Anthropocene will bring in the next few hundred or few thousand years, he feels it more sensible to allow future generations to decide on the date of the transition, when they are able to look at it with the benefit of hindsight.

#### *Conclusion: some pointers on using these data in teaching*

It is important to be aware of the debate over stratigraphic data, but such knowledge ought not to be a goal *in itself*. It opens the door to reflection, and can be worked on in a variety of ways with students and pupils. This debate appears to be a helpful lens through which to analyse the different facets of the polemic concept of the Anthropocene. Though indubitably scientific, it is also a political concept (which will determine the future direction of the human adventure). It is also one that arouses powerful feelings, as can be seen from the academic articles on the subject – clearly, researchers cannot remain neutral on topics so disquieting as those stirred up by the Anthropocene (Wallenhorst, 2019).

This debate also provides a starting point for a critical examination of school curricula. In view of that examination, students (perhaps older students more than young pupils) could be

encouraged to reflect on the socialisation they receive at school. What fundamental truths has school taught us which now appear in a new light, as we venture into the uncharted waters of the Anthropocene?

It is also sensible to examine the political agendas underlying each of the hypotheses for the dawn of the Anthropocene (pointing the finger at certain culprits, serving a particular moral outlook, opening or closing the door to the future).

Whilst there is vigorous debate among experts, we can easily examine the purely anthropological point underlying the various hypotheses. Ultimately, what is at stake in the way in which humans exist on Earth? Looking at the bigger picture, the figure of *homo oeconomicus*, seeking selfishly to maximise their own individual interests, is very much in the foreground.

The Anthropocene also provides the impetus to re-examine modern life, and the prominent dualism between nature and culture. The Anthropocene blurs the boundaries between the two. What is truly 'natural'? Can there be anything genuinely 'cultural' and 'social' that is not anchored in 'nature'? What can be said of our connections with the Earth itself, and with the rest of the living world?

Thus, this scientific debate can also help awaken rational thinking. The Earth keeps a permanent record of our presence and our activities. This much is obvious: it speaks *about* us – but does it speak *to* us... and were we to listen, what would it say?

Balter, M. (2013). Archaeologists say the “Anthropocene” is here – but it began long ago. *Science*, 340, 261-262.

Crutzen, P. J. (2002). Geology of Mankind: “The Anthropocene”. *Nature*, 415, 23.

Doughty, C. E. (2013). Preindustrial human impacts on global and regional environment. *Annual Review of Environment and Resources*, 38, 503-527.

Holtgrieve, G. W. *et al.* (2011). A coherent signature of anthropogenic nitrogen deposition to remote watersheds of the Northern Hemisphere. *Science*, 334, 1545-1548.

Kaplan, J. O. *et al.* (2011). Holocene carbon emissions as a result of anthropogenic land-cover change. *The Holocene*, 21 (5), 775-791.

Lewis, S. L., Maslin, M. A. (2006). Defining the Anthropocene. *Nature*, 519, 171-180.

MacFarling Meure, C. *et al.* (2006). Law Dome CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O ice core records extended to 2000 years BP. *Geophysical Research Letters*, 33, 1-4.

Masco, J. (2010). Bad weather: On planetary crisis. *Social studies of Science*, 40(1), 7-40.

Nature (2011). Editorial. The human epoch. Official recognition for the Anthropocene would focus minds on the challenges to come. *Nature*, 473, 254.

Rockström, J. (2015). Bounding the Planetary Future: Why We Need a Great Transition. *Great transition initiative*, April, 1-14.

Roebroeks, W., Villa, P. (2011). On the earliest evidence for habitual use of fire in Europe. *Proceedings of the National Academy of Science, USA*, 108 (13), 5209-5214.

Ruddiman, W. F. (2003). The anthropogenic greenhouse era began thousands of years ago. *Climatic Change*, 61, 261-293.

Ruddiman, W. F. (2013). The Anthropocene. *The Annual Review of Earth and Planetary Sciences*, 41, 45-68.

- Ruddiman W. F. *et al.* (2014). Does pre-industrial warming double the anthropogenic total? *The Anthropocene Review*, 1, 1-7.
- Steffen, W. *et al.* (2004). *Global Change and the Earth System. A Planet Under Pressure, The IGBP Book Series*. New York: Springer.
- Steffen, W. *et al.* (2011a). The Anthropocene: conceptual and historical perspectives. *Philosophical Transactions of the Royal Society*, 369, 842-867.
- Steffen, W. *et al.* (2011b). The Anthropocene: From global change to planetary stewardship. *Ambio*, 40(7), 739-761.
- Steffen, W. *et al.* (2016). Stratigraphic and Earth system approaches to defining the Anthropocene. *Earth's Future*, 4, 1-22.
- Steffen, W. *et al.* (2018). Trajectories of the Earth System in the Anthropocene. *Proceedings of the National Academy of Sciences*, 115 (33), 8252-8259.
- Wallenhorst, N. (2019). *L'Anthropocène décodé pour les humains*. Paris: Le Pommier.
- Waters, C. N. *et al.* (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science*, 351, 137-147.
- Waters, C. N. *et al.* (2014). Evidence for a Stratigraphic Basis for the Anthropocene. In R. Rocha, J. Pais, J. Kullberg, S. Finney (eds), *STRATI 2013*, Springer Geology, Springer, Cham, pp. 989-993.
- Waters, C. N. *et al.* (2015). Can nuclear weapons fallout mark the beginning of the Anthropocene Epoch? *Bulletin of the Atomic Scientists*, 71 (3), 46-57.
- Wolfe, A. P. *et al.* (2013). Stratigraphic expressions of the Holocene–Anthropocene transition revealed in sediments from remote lakes. *Earth-Science Reviews*, 116, 17-34.
- Zalasiewicz, J. *et al.* (2014). When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal. *Quaternary international*, 30, 1-8.
- Zalasiewicz, J. *et al.* (2010). The new world of the Anthropocene. *Environmental Science & Technology*, 44, 2228–2231.
- Zalasiewicz, J. *et al.* (2011b). The Anthropocene: A new epoch of geological time? *Philosophical Transactions of the Royal Society*, 369, 835-841.
- Zalasiewicz J. *et al.* (2017a). Anthropocene: its stratigraphic basis. *Nature*, 541, 289-289.
- Zalasiewicz, J. *et al.* (2017b). Making the case for a formal Anthropocene Epoch: an analysis of ongoing critiques. *Newsletters on Stratigraphy*, 50, 205-226.
- Zalasiewicz, J. *et al.* (2012). Response to Autin and Holbrook on “Is the Anthropocene an issue of stratigraphy or pop culture?” *GSA Today*, 22(7), e21-e22.

Nathanaël Wallenhorst is Professor at the Catholic University of the West (UCO) and dean of the Faculty of education. He is Doctor of Educational Sciences and Doktor der Philosophie (first international co-supervision PhD), and Doctor of Environmental Sciences and Doctor in Political Science (second international co-supervision PhD). He is the author of twenty books on politics, education, and anthropology in the Anthropocene. Books (selection) :*The Anthropocene decoded for humans* (Le Pommier, 2019, in French). *Educate in Anthropocene* (ed. with Pierron, Le Bord de l'eau 2019, in French). *The Truth about the Anthropocene* (Le Pommier, 2020, in French). *Mutation. The human adventure is just beginning* (Le Pommier,

2021, *in French*). *Who will save the planet?* (Actes Sud, 2022, *in French*). *Vortex. Facing the Anthropocene* (with Testot, Payot, 2023, *in French*). *Political education in the Anthropocene* (ed. with Hétier, Pierron and Wulf, Springer, 2023, *in English*). *A critical theory for the Anthropocene* (Springer, 2023, *in English*).