

## Conference Report

### SECOND ANTHROPOCENE WORKING GROUP MEETING

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Colin Waters, British Geological Survey, UK

Jan Zalasiewicz, Department of Geology, University of Leicester, UK

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The second meeting of the Anthropocene Working Group (AWG) was held at the McDonald Institute for Archaeological Research, University of Cambridge, on 24th and 25th November 2015. It took the form of a workshop with 12 members of the working group and numerous archaeologists from the Institute in lively conversation with each other. Discussion was focused on anthropogenic strata and matters of chronostratigraphy.

The AWG was set up in 2009 to consider the case for formalizing the term 'Anthropocene' in the Geological Time Scale. The working group reports to the Subcommission on Quaternary Stratigraphy, which sits within the broader framework of the International Commission on Stratigraphy (ICS). Unusually for a working group of the ICS, it consists of researchers from a wide variety of Earth Sciences, including archaeology.

The meeting was opened by Simon Stoddart of the McDonald Institute, who in welcoming everyone pointed to the unique situation of the Institute as a forum for inter-disciplinary debate, located as it is between the Sedgwick Museum of Geology and the Museum of Anthropology and Archaeology. He outlined three initial areas of debate that archaeology might contribute. Firstly, archaeology offers the foil of detailed regional sequences to the global concerns of geology and archaeology, so much so that an *Anthropoeurocene* might be dated earlier than the Anthropocene at a global scale. Secondly, archaeology can offer levels of chronological precision that may be helpful to the Anthropocene debate. Thirdly, some local art installations are pre-adapted to the Anthropocene debate, as cautionary tales of culture interacting with uniformitarian process. Figures and details of two local artworks visited/discussed during the course of the workshop can be found at the end of this report.

Jan Zalasiewicz of the University of Leicester likewise welcomed participants on behalf of the AWG and thanked the McDonald Institute for hosting the meeting, before going on to introduce the first paper on main themes and issues of the Anthropocene debate.

Colin Waters of British Geological Survey posed key questions regarding the stratigraphic definition of the Anthropocene. Have humans changed Earth systems to such an extent that there is now a geological signature distinct from that of the Holocene and earlier epochs? Is such a signature durable enough to persist in the geological record? And if so, when did the stratigraphic signal become recognizable worldwide? A summary was given of different positions on the start of the Anthropocene, from the Early Anthropocene argument through to that of the recent paper co-authored by 25 AWG members – proposing that the most appropriate level to mark the start to be the world's first nuclear bomb explosion on July 16th 1945 at Alamogordo in New Mexico. Of course this generated considerable debate and the workshop got off to a good start.

Jan Zalasiewicz outlined the principles of chronostratigraphy and the structure of deep time in geology, indicating how time is divided up into eons, eras, periods, epochs and ages. The ICS International Stratigraphic Chart was shown, zooming in to look in detail at particular boundaries where a GSSP (Global Stratotype Section and Point) has been placed to mark the end of a chronological interval and the beginning of a new one.

Discussion following the paper focused on differences between time boundaries in geological time and in archaeological time. One argument was that synchronous boundaries have zero time-depth and thus can be drawn as a straight line no matter what the time-scale deployed. An alternative, perhaps non-geological, argument was that a synchronous boundary on a scale of deep time would appear as a diachronous boundary on a much shallower archaeological timescale, and vice-versa. An example of such a diachronous boundary was presented in the form of a time-chart by the late Andrew Sherratt, showing the start of agriculture in different parts of Europe and the Near East.

A theme of the workshop was the difference in approach of geologists and archaeologists towards anthropogenic strata, whether characterized as 'artificial ground' or 'archaeological stratigraphy'. The British Geological Survey has been mapping artificial ground routinely since the 1970s, and Colin Waters took us through geological classification systems used. He also introduced the concept of 'anthroturbation', the range of which extends far beyond ground level to include deep mining, fracking, and other subsurface disturbance. Matt Edgeworth looked at the complexity of detail which archaeologists encounter and record in their investigations of anthropogenic strata. Correspondences and contrasts between geological and archaeological approaches were addressed by Craig Cessford's presentation. He described an archaeological excavation at St Clement's Garden in Cambridge, and his experience of using geological borehole data to supplement evidence obtained from open area excavation. It was an excellent site to use as an example. As well as the archaeological evidence on view, there was also the construction work going on in the background, reminding us that the stratigraphy of the Anthropocene is still in the process of formation.

Rory Flood of the FRAGSUS project cited evidence of a series of sedimentary cores from Malta, which he argued did not support the case for the Anthropocene. It was good to have his and other sceptical voices in the workshop, counterbalancing the views of those who are already convinced of the usefulness of the concept. Erle Ellis of the University of Maryland outlined some very different perspectives. He proposed three key areas of Anthropocene debate: 1) dating the start, 2) investigating the ecology of an anthropogenic biosphere, and 3) carrying out a global archaeology of the human transformation of Earth. A question posed by Ellis was: could archaeology, with its focus on stratigraphic evidence of human impact on landscapes, be one of the core sciences in the study of the Anthropocene?



Figure 1. Workshop participants on the steps of the McDonald Institute (photo: Cath Neal)

Colin Waters discussed the first appearance and spread of different types of artefact (or technofossils) and novel materials through time, looking in particular at those materials which might offer support for a mid-20<sup>th</sup> century start to the Anthropocene, such as concrete, fly ash, fallout from nuclear testing and plastics. Matt Edgeworth gave a specific example of a 20<sup>th</sup> century stratigraphic context where plastics and a great diversity of other novel materials are to be found – quarry pits from which clay was extracted for manufacture

of bricks in Bedfordshire, UK, subsequently backfilled with landfill rubbish up to 70m deep. He drew attention to the remarkable contrasts between assemblages of objects to be found in landfill with assemblages of fossils from the Jurassic layers below, which the clay pits had cut down into. The paper was supported by a short film of the cutting of the pits with huge drag-line excavating machines and subsequent landfilling shown on a screen at tea-breaks – the formation of Anthropocene stratigraphy in action, so to speak.

The last paper on Tuesday afternoon was by Mark Williams, who explored human influence on Earth from a biological or 'neobiological' perspective. He asked whether the shift from the Holocene to the Anthropocene might be understood as a shift in state of Earth systems, comparing it with other major events in the history of life - such as the explosion in number and diversity of life forms at the Precambrian/Cambrian boundary, or the mass extinctions at the Cretaceous-Tertiary (KT) boundary. Current rates of extinction by some estimates are one thousand times background levels, and this seems to be a distinctive feature of the Anthropocene. But extinction events have happened before many times in Earth history. What has no geological precedent is the mass global transfer of species between continents, enabled by modern transport systems and networks. These were some of the issues we took away to talk about over a wonderful dinner at Magdalene College that evening.

Wednesday morning kicked off well with an absorbing paper from Jeremy Bennett on agricultural terracing in Malta. Terracing is a type of anthropogenic landform, or anthroscaping, which has shaped large parts of the terrestrial surfaces of the Earth. Far from merely being a passive record of past human activity, it is an essential element of the material infrastructure which continues to support agricultural economies in many parts of the world. On connected themes, the next paper by Marc van der Linden explored evidence for early farming in Europe, with a focus on recent work in Ireland and the West Balkans. Such evidence supports the case for Early Anthropocene arguments based on the widespread impacts of agriculture.

Tracy Rogers brought us back to the present in her paper on loss of biodiversity. She compared the current situation with past periods of extinction, such as the collapse of megafauna. Crucially however, she not only looked at species in decline, but also some which are flourishing – showing how humans are creating favourable habitats as well as destroying others. Cosmopolitan species in particular, such as the urban fox, are well suited to city environments. Domestic animals too are thriving in great numbers (and here this talk intermeshed with some of the themes of Mark William's paper the previous day). All this will be evident in the future stratigraphic and fossil record.

The final group of papers examined geochemical signatures and related issues. Ian Fairchild summarised the variety of information about anthropogenic activity which can be gained from speleothems in caves. Sometimes formations directly overlie archaeological traces such as engravings on cave walls or footprints on cave floors, in which case there is a clear stratigraphic relation, and the speleothem can be used to date the underlying deposit. But

this paper revealed how geochemical analysis of speleothems can also tell us much about changing conditions in the environment outside too.

Michael Wagemann presented the case for an Early Anthropocene mining/smelting signal for the period 3600-2800BP. Extensive copper mining and smelting in the Bronze Age gave rise to atmospheric pollution which can be detected in levels of lead in peat bogs, floodplain and lake sediments and Arctic ice cores, though the signal becomes much more diachronous when the study area is extended from the northern into the southern hemisphere. Robyn Veal followed with a paper which had many intermeshing themes on the use of wood as fuel in metalworking and other activities, and the important information that charcoal as an archaeological material can convey.

Alex Wolfe's paper focused on evidence provided by sediments in remote mountain lakes in a wide range of locations in North and South America, Greenland and the Canadian Arctic. Wolfe argued that measurements of mercury fluxes and nitrogen stable isotopic depletion, combined with changes to biota, fit in well with the proposed mid-20<sup>th</sup> century start for the Anthropocene. He followed up his analysis with an elegant argument in favour of 1950 as a start date.

This generated much discussion, especially with regard to the effects and implications of having such a precise date for the end of one period and the beginning of another. An example is provided by the Bedfordshire clay pits mentioned the previous day. In some cases the pits were excavated before 1950 (which would place their cuts in the Holocene) but were filled with landfill rubbish after 1950 (which would place the fills in the Anthropocene). This would give rise to the seemingly unusual effect of 'cut' and 'fills' of the same archaeological feature being assigned to two separate geological epochs, either side of the epochal boundary.

Could a GSSP be placed at the base of landfill deposits to mark the start of the proposed new epoch? The problem from a geological point of view is that there is a time-gap of millions of years between the artefact-rich landfill of the Anthropocene and the fossil-rich marine sediments of the Jurassic period directly below - a good example of an *unconformity*, although one of the geological forces which created it is human. GSSPs are rarely placed on such erosional stratigraphic surfaces, because of lack of continuous succession of deposits in the relevant transitional time period. However, the lower boundary of anthropogenic strata could perhaps provide suitable candidate locations for GSSP placement elsewhere, where it consists not of an unconformable surface but a depositional surface (on which sediments have accumulated or been intentionally placed), and where the necessary conditions of continuous succession are met.

Another reason why the lower boundary of anthropogenic deposits may be deemed unsuitable for marking the start of the Anthropocene is that it is diachronous, changing in date along different parts of its surface. In places it is 20<sup>th</sup> century in date, as is the case with the clay pits, but nearby it is medieval or Roman or prehistoric in date of origin. On a

geological time scale this time variability is small and could even be described as high precision, with a date range of mere thousands rather than millions of years. But on the timescale of human history and as regards currently attainable time-resolution in recent deposits it does not give the precision needed for a boundary between the Holocene and the Anthropocene.

In some contexts the epochal boundary might coincide with physical boundaries *within* landfill deposits. Envisage a site where the dumping of landfill took place first in the 1930s-1940s (Holocene) and then again in the 1960s-1970s (Anthropocene). In such a case, the two landfill deposits would be clearly distinguishable by the content of the respective fill materials, with the later one, say, including significant plastics but the earlier one lacking them.

To square the diachronous lithostratigraphic evidence of physical strata in the ground with the chronostratigraphic requirement for a globally synchronous timeline is one of the central issues of the Anthropocene debate.

We were short of time and Martin Jones generously offered to forsake his paper to allow time for much-needed debate on these and related topics. The offer was accepted but with regret (and apologies from the organizers for allowing the schedule to slip) for his paper on atmospheric methane rises and the domestication of water would surely have been one of the highlights of the meeting. It would have brought William Ruddiman's important argument on the Early Anthropocene into the discussion, and explored connections with early archaeological evidence of rice production and water control.

This was one of those occasions, increasingly common in the context of AWG discussions on the Anthropocene, when geologists, geochemists, palaeobiologists, landscape ecologists, archaeologists and others gathered to discuss issues that cannot be contained within the confines of one discipline alone. The range of topics covered was extremely wide, and challenging for all participants, for we were all taken out of our disciplinary comfort zones. But it was invigorating and engaging for those very reasons. Grappling with the multi-disciplinary aspects of such a diverse array of stratigraphic and other forms of evidence is surely one of the material challenges that the Anthropocene presents us with.

## Postscript: monuments to anthropogenic strata?



Figure 2. Workshop participants contemplating the sculpture *Earthbound Plant* by Antony Gormley (2002), outside the McDonald Institute, Cambridge (photo: Cath Neal). Easily overlooked, this is a life size cast-iron statue of a human figure buried upside down and entirely encased in anthropogenic strata, with only the soles of the feet showing on the ground surface.



Figure 3. The Core by Michael Fairfax, 2001 (photo: Matt Edgeworth), a bronze engraved column at Chesterton Corner, Cambridge. The 3.5m high column represents the depth of anthropogenically-modified ground at this point, as revealed and recorded during construction of a sewer shaft.

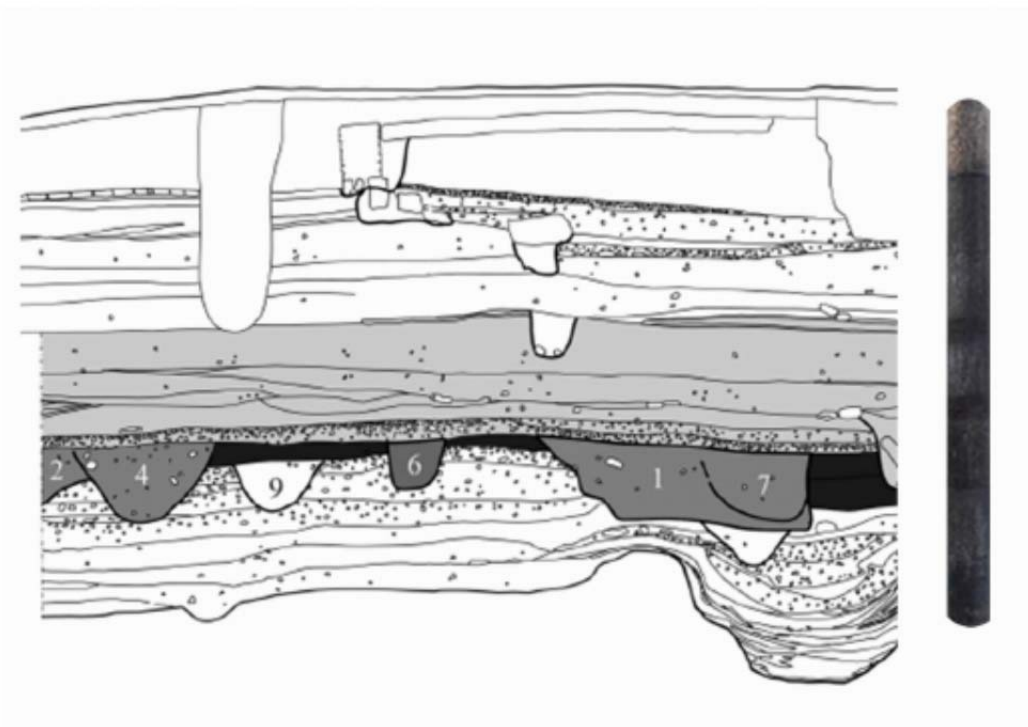




Figure 4. Vertical profile of anthropogenic strata from the cylindrical inner sides of the sewer shaft (Cambridge Archaeological Unit). The 3.5m high column of The Core serves as approximate scale. Graves of an Anglo-Saxon execution cemetery are numbered 1-7 (section reproduced from 'Middle Anglo-Saxon Justice: the Chesterton Lane Corner execution cemetery and related sequence, Cambridge' by Craig Cessford, Alison Dickens, Natasha Dodwell and Andrew Reynolds, 2007, in *Archaeological Journal*, 164:1). The sewer shaft itself is now part of this stratigraphic sequence, which is still in the process of formation and subject to further transformation in the future.

### **Acknowledgements**

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### **Note**

As this is being reported in TEA, a paper by 24 members of the AWG has just been published by *Science*. It is entitled 'The Anthropocene is functionally and stratigraphically distinct from the Holocene'. The full citation details are:

Colin N. Waters, Jan Zalasiewicz, Colin Summerhayes, Anthony D. Barnosky, Clément Poirier, Agnieszka Gałuszka, Alejandro Cearreta, Matt Edgeworth, Erle C. Ellis, Michael Ellis, Catherine Jeandel, Reinhold Leinfelder, J. R. McNeill, Daniel deB. Richter, Will Steffen, James Syvitski, Davor Vidas, Michael Wagemann, Mark Williams, An Zhisheng, Jacques Grinevald, Eric Odada, Naomi Oreskes, and Alexander P. Wolfe. 2016. The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science* 8 January 2016: 351 (6269).

The main author Colin Waters can be heard speaking about the challenge of 'Defining the Anthropocene' in this BBC podcast: <http://www.bbc.co.uk/news/science-environment-35259198>