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The politics of the anthropocene: a dialogue

Andrew Barry and Mark Maslin

This paper stages a dialogue between a human geographer and a physical geographer about the concept of the Anthropocene. The aim of the dialogue is not to arrive at an agreement about how the Anthropocene should be defined, but rather to open up the question of the politics of the concept and its definition. The dialogue revolves around three issues: (1) the politics of the debate about the geoscientific definition of the Anthropocene Epoch; (2) the relation between the geoscientific debate about the Anthropocene and the burgeoning literature on the Anthropocene in the social sciences and humanities, including human geography; (3) the relation between geoscientific and political concepts.

Key words Anthropocene; politics; geosciences; Earth system; interdisciplinarity

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Introduction

In Paul Crutzen and Eugene Stoermer's (2000) formulation the Anthropocene Epoch[1] was associated with a series of phenomena, including species extinction, the depletion of fossil fuel resources, and the release of sulphur and nitrogen oxides into the atmosphere, as well as the impact of greenhouse gases, including CO_2 and methane. But in turn, as Crutzen later argued, the existence of the Anthropocene had evident political and ethical implications: it implied that 'humanity' should accept the enormity of its responsibility as 'stewards of the earth' (Crutzen and Schwägerl 2011) and it even pointed to the necessity of geoengineering as a solution to the problem of climate change (Crutzen 2006; cf. Szerszynski *et al*. 2013; Hulme 2014). In this account, the Anthropocene was not just the name for a geological epoch, but a sign of the need for a new regime of global environmental governance.

One response to this political and ethical argument is an explicitly critical one. In this critical view, the current enthusiasm of the concept of the Anthropocene does not reflect the evidence of scientific research, but the fact that we live in what writers such as Slavoj Žižek would call a post-political age. The Anthropocene is not so much a marker of an epochal transformation but a manifestation of an era in which democratic political debate has been displaced by a concern with the demands of economic management and the views of 'enlightened specialists' (Žižek 2004, 72). In this critical account the implications of the introduction of the concept of the Anthropocene are thoroughly anti-political (cf. Barry 2002; Swyngedouw 2013); the concept turns the question of the politics of the planet into a matter of good governance, rather than something about which it matters to disagree. Indeed, according to many observers the Anthropocene does seem to justify the formation of a global technocracy (Stengers 2009; Stirling 2014). Moreover, as critics suggest, in so far as the concept implies that 'humanity' should shoulder responsibility for the Earth it obscures the extent to which the origins of the Anthropocene are, in fact, due to the actions of a small fraction of humanity (Luke 2015; Bonneuil and Fressoz 2015).

In this situation, this paper is intended as a contribution to the debate about the politics of the concept of the Anthropocene. However, rather than address the question of whether the Anthropocene either justifies or, alternatively, legitimatises a new post-political regime of environmental governance, our initial focus is narrower. Our starting point is with the details of the specifically geoscientific debate itself, to which one of us (MM) has made a recent contribution (Lewis and Maslin 2015a). Our contention is that the politics of the Anthropocene revolve not just around the question of the relation between the Anthropocene and global environmental governance, but also around the ways in which the Epoch is formally defined by geoscientists.

The paper takes the form of a dialogue. In adopting this form, we highlight our disagreements as well as agreements about the politics of the Anthropocene. Our disagreement can be briefly summarised. In the context of the burgeoning debate about the politics and meaning of the concept, Mark Maslin argues that the geoscientific debate about the concept of the Anthropocene needs to be more rigorous, in order to sustain a clear distinction between the specifically geoscientific 'formal' debate about the Anthropocene and the growing body of literature on the Anthropocene within the social sciences and humanities. There is a need for more scientific rationality to attempt to *depoliticise* the definition of the Anthropocene Epoch. By contrast, Andrew Barry argues that the geoscientific debate about the Anthropocene needs to address a series of political questions, but more rigorously than it has hitherto. As a result, the intervention of social scientists and historians in the natural scientific debate about the Anthropocene should be encouraged. In staging a dialogue, our aim is not to reach a consensus about the politics of the concept of the Anthropocene, nor do we offer a synthesis of human and physical geographical accounts of the concept (cf. Barry and Born 2013, 10–11). The dialogue is, as Chantal Mouffe's work would suggest, intended to be agonistic and, in this way, to contribute to a more inclusive debate that both cuts across and interrogates the shifting relation between the natural and social scientific accounts of the Anthropocene (Mouffe 2013; Barry and Born 2013, 12).

Dialogue

AB: Over the last decade the concept of the Anthropocene seems to have spread virally, crossing the boundaries between the natural and social sciences and humanities with remarkable ease. As far as I am aware, the term has been taken up by a growing number of writers in human and environmental geography (e.g. Dalby 2009; Clark 2012; Yusoff 2013a; Castree 2014; Johnson *et al*. 2014; Lorimer 2015), history (Chakrabarty 2009; Dukes 2011), social anthropology (Kirksey and Helmreich 2010), sociology (Szerzynski 2012), economics (Sachs 2007) science and technology studies (Latour 2013, 2016), and the 'ecological humanities', as well as by artists, museum curators (HKW 2014; Möllers 2014; Tate Modern 2015), and journalists. But before we address the question of the remarkable significance of the concept of the Anthropocene in the social sciences and humanities, I'd like to ask a preliminary question. Why do you think the scientific community has so rapidly taken up the concept in the first place?

MM: The take up of the concept has certainly been rapid. Commentators have already argued that the Anthropocene concept marks a paradigm shift within science (Hamilton 2015; Maslin and Lewis 2015). Indeed, there is general scientific agreement that human activity has had a geologically recent, yet profound, influence on the Earth system (Steffen *et al*. 2015a; Zalasiewicz *et al*. 2015a; Lewis and Maslin 2015a). The magnitude, variety and longevity of human-induced changes to the lithosphere, hydrosphere, cryosphere, biosphere and atmosphere suggest that humans have indeed moved the Earth system beyond the Holocene Epoch (Waters *et al*. 2016) as our geological period is currently formally referred to. There is, however, another reason why I think the concept of the Anthropocene has been accepted within science so fast that more directly relates to the politics of the concept. This is because the concept encompasses *all* human impacts on the environment and thus engages all of environmental science. For the last two decades the central message about human influence on the environment has been about climate change (Maslin 2014). Because of the continued failure of politicians to address what climate scientists see as just a greenhouse gas pollution problem, more and more effort has been made to communicate the threats of climate change. However, this has drowned out the public and political discussion of other very real impacts that humans are having on the Earth system, including environmental degradation, biodiversity loss, disruption of the biogeochemical cycles and pollution. Two major concepts have emerged in the last decade to include these other impacts: the first is Planetary Boundaries (Rockström *et al*. 2009; Steffen *et al*. 2015a) and the second is the Anthropocene. There are major concerns regarding the Planetary Boundaries concept, including its political implications and its anthropocentrism (Lewis 2012), but as yet the Anthropocene concept has remained relatively unscathed. I would argue that the *inclusivity* of the Anthropocene concept allows scientists to urge for political actions that address issues that include but go beyond climate change. Thus the Anthropocene is inherently a political concept; it enlarges the scope of what we take to be the politics of the Earth.

AB: OK, one aspect of the politics of the concept of the Anthropocene is clear; the concept serves to render a wider range of changes to the Earth system visible. But while I accept that there is broad scientific agreement about the value of the concept of the Anthropocene, there is still considerable disagreement about the concept, which is clearly evident in your paper (Lewis and Maslin 2015a), as well as the various publications of members of the Anthropocene Working Group (AWG). These disputes seem to focus on two critical sets of questions. First, 'should the Anthropocene be defined as a formal unit of geological time? Is there enough stratigraphical evidence for a formal geological time unit and would it be useful to Earth scientists

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(a somewhat different matter)?' And second, and if so, then 'when should its beginning be best placed: opinions have ranged from tens of thousands of years ago, to decades ago, and indeed to some point in the future; how should it be defined'? (AWG 2013a and 2013b).

MM: These disputes between scientists about the formal definition of the Anthropocene Epoch have to be understood in the context of a long and bureaucratic process that has been followed for every single geological boundary definition (Smith *et al*. 2015). But before I address the politics of this process, it is critical to recall how geological time is understood. Geological time is divided into a hierarchical series of ever-finer units or 'stages' (Smith *et al*. 2015). The present, according to *The Geologic Time Scale* (or GTS 2012), is in the Holocene Epoch (Greek for 'entirely recent'; started 11 650 BP, where BP (before present) is defined as 1950), within the Quaternary Period (started 2.58 million years ago), within the Cenozoic Era ('recent life'; started 65.5 million years ago) of the Phanerozoic eon ('revealed life'; started 541 million years ago). Divisions represent differences in the functioning of Earth as a system and the concomitant changes in the resident life forms. Larger differences result in classifications at higher unit levels.

Formally, geological time units are defined by their lower boundary, that is, their beginning. Boundaries are demarcated using a GSSP (Global Boundary Stratotype Section and Point), or by an agreed date, termed a GSSA (Global Standard Stratigraphic Age). For a GSSP, a 'stratotype section' refers to a portion of material that develops over time (rock, sediment, glacier ice), and 'point' refers to the location of the marker within the stratotype. These 'golden spikes' are a single physical manifestation of a change recorded in a stratigraphic section, often reflecting a global-change phenomenon. However the definition of each GSSP is unique and combines these requirements with the practicality of the time period and sediment type.

GSSP markers are then complemented by a series of correlated changes, also recorded stratigraphically, termed auxiliary stratotypes, indicating widespread changes to the Earth system occurring at that time. An exemplary GSSP is the Cretaceous–Palaeogene period-level boundary, and the start of the Cenozoic era, when non-avian dinosaurs declined to extinction and mammals radically increased in abundance. The GSSP boundary marker is the sediment layer in which the peak in iridium, the residual of bolide impact with Earth, occurs dated at 65.5 million years ago. Alternatively, following a survey of the stratigraphic evidence, a GSSA date may be agreed by committee to mark a time unit boundary. GSSAs are common in the Precambrian (>630 million years ago) because well defined geological markers and clear events are less obvious further back in time.

Hence there are clear scientifically agreed criteria for defining geological time units, and the politics of the process revolves, in part, around the application or interpretation of these criteria. The AWG of the Subcommission of Quaternary Stratigraphy will review all the evidence and produce a recommendation. For this recommendation to be accepted, a supermajority vote of the International Commission on Stratigraphy (ICS), and finally ratification by the International Union of Geological Sciences (IUGS), are required (see Finney 2013 for full details).

AB: What is evident about the geoscientific debate about the Anthropocene that you describe is the importance of evidence of its beginning or boundary, and whether this boundary should be understood as a GSSA or GSSP. But there is a politics to these requirements for evidence and the institutional processes through which they are enacted, which are specific to stratigraphy, as you make clear. These requirements point to three aspects of the politics of the concept of the Anthropocene. First, they provide a focus for a debate amongst geoscientists about how these rules should be interpreted in practice; this is one element of the disagreements between yourselves and the AWG and others (Lewis and Maslin 2015a). Second, these requirements serve both to focus and limit the scope for controversy. Some argue, for example, that the idea of establishing *any* single boundary is problematic, given the diversity of processes involved. Third, there is a politics to the institutional process itself, which gives authority to the members of the IUGS, thereby necessarily excluding the voice of other interested parties.

MM: I agree that each group of scientists can and does interpret the rules of stratigraphy in their own way, and that this generates a lot of institutional politics within the scientific community. For example the recent Zalasiewicz *et al*. (2015a) commentary and other papers emerging from the AWG argue that a GSSP-defined boundary should not be placed at the peak of the excursion, which defines the 'golden spike', but rather at the beginning. This was their reasoning behind their suggested GSSA of 1945 as this was when the first nuclear bomb test occurred. However, there are examples in the geological record that contradict this interpretation. A first example: the base of the Cenozoic Era, Paleogene System, Paleocene Series and Danian Stage is defined as the reddish layer at the base of the 50 cm thick, dark boundary clay found west of El Kef, in Tunisia, where it coincides with the Iridium Anomaly fallout from a major asteroid impact. The key point here is that the boundary is defined by the red clay layer that contains the iridium peak, not by the start of the rise in iridium. In more recent papers the AWG now favours the radio-carbon bomb spike at 1964 (Waters *et al*. 2016).

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What is unclear is whether these different interpretations of stratigraphy, even within the same group of scientists, are scientifically or politically motivated. Evidence of the former is suggested by the robust refutation of the AWG 1945 suggestion published by Walker *et al*. (2015); while the huge number of papers with different dates and ideas that have been published over the last few years by the AWG mean that its members have been, at least partially, swayed by political considerations.

AB: Your last point is an important one, which I'd like to probe further. Crutzen and Stoermer's initial proposition was, of course, that the Anthropocene Epoch boundary should be associated with the industrial revolution. However, their contention that the Anthropocene began in the late eighteenth century with the invention of the steam engine is problematic not just on scientific grounds but also from the point of view of the history and sociology of technology (Mackenzie 1996). As Marx pointed out, the idea that one should think of the steam engine (or any other technology) as the cause of historical change is surely mistaken: 'it was', as he put, 'the invention of machines that made a revolution in the form of steam engines necessary' (Marx 1973 [1867], 497), or in Gilles Deleuze's more recent formulation, following Foucault, 'technology is social before it is technical' (Deleuze 1988, 40).

Nonetheless, despite its faults, Crutzen and Stoermer's account raises the question of whether it is possible to incorporate an account of capitalism into an account of the Earth system, and vice versa. Their industrial revolution hypothesis associates the Anthropocene with a recognisable period in the development of capitalism. However, an explicit interest in economic and political history has been quite marginal to the work of the AWG. Although the group have posed the question of the potential use of the concept to 'other scholarly disciplines' (AWG 2013b, 2), the formal involvement of 'other scholarly disciplines' has, in practice, been highly circumscribed (Castree *et al*. 2014; Lövbrand *et al*. 2015; Luke 2015). Although you define the Anthropocene in strictly stratigraphic terms, you also give explicit recognition to the role of colonialism and the formation of the capitalist world system in the transition from the Holocene. As you put it:

> we suggest naming the dip in atmospheric CO_2 the 'Orbis spike' and the suite of changes marking 1610 as the beginning of the Anthropocene the 'Orbis hypothesis', from the Latin for world, because post-1492 humans on the two hemispheres were connected, trade became global, and some prominent social scientists refer to this time as the beginning of the modern 'world-system'.
>
> Lewis and Maslin (2015a, 175; see also Hornborg *et al*. 2007).

In introducing an account of the world system into your account, how far are you prepared to open up the geoscientific debate about the Anthropocene to the social sciences?

MM: I am of the view that the social sciences and humanities should be fully involved in the Anthropocene debate. Because first the geosciences need to know the political ramifications of the alternative start dates proposed for the Anthropocene Epoch. Second, if a formal definition of the Anthropocene Epoch is accepted, this is only one of many equally valid definitions of the Anthropocene and others must be continually explored. It has been exciting to see how the concept of the Anthropocene has engaged different subjects in ways that climate change and sustainability have not. Though many disciplines have embraced the wider discussion of the Anthropocene, many scientists are bemused by some of the contributors' negative view of the Anthropocene. The idea that concepts can be critiqued or deconstructed on purely theoretical grounds is common in critical social science, but is an alien approach in science, whereby if a concept or a theory is shown to be incorrect then a modified or alternative concept or theory is presented. To enable the conversation to occur between subjects, I suggest it needs to be conducted in a constructive rather than a destructive debate. My questions to you are how do you think the social science can rise to the challenge posed by a pan-disciplinary concept such as the Anthropocene and can social science develop a constructive dialogue and interaction with the natural sciences?

AB: My starting point would be to acknowledge that while the social sciences can offer a critique of the concept of the Anthropocene, as you say, the geoscientific concept equally poses challenges to the humanities and social sciences. In Chakrabarty's formulation, the Anthropocene hypothesis, 'severely qualifies' humanist accounts of histories of Modernity/Globalisation (Chakrabarty 2009, 207). In other words, accounts of capitalism need to attend to the critical and marginalised importance of non-human agencies in the life of capital (Mitchell 2002). This is a radical proposition for most social scientists. It means that we have to address the history of biological organisms and geological processes, which are typically understood as lying outside of (human) history (Clark 2010; Hird 2010). How might we rethink human history and human origins in geological rather than biological terms (Yusoff 2015)? What would the Anthropocene look like if considered not from the perspective of humanity, but from the perspective of non-human species? These are important questions. But they also suggest that the idea of the Anthropocene highlights not just the limits of social scientific accounts of history, but also the limits of the

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geosciences. How should the introduction of the concept of the Anthropocene, in so far as the Anthropocene includes human history, qualify geological accounts of the history of the Earth and, indeed, the concept of the Earth system? You suggested earlier that there were two debates about the Anthropocene: one informal and the other formal. I would like to pose the question: how distinct are these debates in practice, and how distinct should they be? Moreover, is it appropriate to arrive at a *specific* date for the start of the Anthropocene, given that the concept is intended to capture the effect of a series of different dynamics, which operate over various time-scales? This is very clear in your paper (Table 1, p. 175). Social scientists would be shocked by the idea that one could or should mark, for example, the beginning of capitalism so precisely. After all, whatever capitalism is taken to be, there is no singular marker for its beginning. Likewise, whatever the Anthropocene is, it is surely the product of multiple geological dynamics and historical trajectories.

MM: You pose two questions to consider, the first is how much influence should the social sciences and humanities and society more broadly have on the definition of the Anthropocene. The second is whether a single date can be used to define the Anthropocene Epoch that we return to later in this paper. I suggest that we need to examine the politics of the concept of the Anthropocene in the context of the history of science, if these questions are to be answered. This is because current science cannot be seen in isolation from the accumulation of past observations, experiments and theories that have progressively improved our understanding of the world; exactly the same is true for the discussion of human influence on the Earth system and thus geology. I would fundamentally disagree with Hamilton and Grinevald (2015) that the Anthropocene emerged as a whole new concept with the development of Earth-system science, and that we can therefore ignore the contributions of earlier geologists and geographers (Lowenthal 2016).

Of course, human-related geological time units have a long history (Davis 2011). I would argue that their definitions have been deeply influenced by the prevailing religious and political ideas and concerns. In the late eighteenth century, Buffon divided Earth's history into seven epochs paralleling the seven-day creation story, with a human epoch being the seventh and final epoch. In 1854, the Welsh geologist and professor of theology Thomas Jenkyn published 'the human epoch' based on the likely future fossil record; he even calls it the Anthropozoic. Similarly, the Reverend Haughton's 1865 *Manual of geology* describes the Anthropozoic as the 'epoch in which we live' (Haughton 1865). In 1830 Charles Lyell proposed that contemporary time be termed the Recent epoch on the basis of three considerations: the end of the last glaciation, the then-believed coincident emergence of humans, and the rise of civilisations. In the 1860s, the French geologist Paul Gervais internationalised the term, calling it the Holocene. Most nineteenth-century geological textbooks, therefore, featured humans as part of the definition of the most recent geological time unit (Rudwick 2005; Davis 2011). Lewis and Maslin (2015a) note that this general agreement for a separate human epoch was influenced more by theological concerns than stratigraphic evidence, as it retained humans at the apex of life on Earth.

In the twentieth century geologists in the West increasingly used the term Holocene for the current epoch, and Quaternary for the period. Meanwhile, in 1922 the Russian geologist Aleksei Pavlov described the present day as part of an 'Anthropogenic system (period) or Anthropocene' (Shantser 1979). The Ukrainian geochemist Vladimir Vernadsky argued humans were a geological force by combining the new idea of the biosphere with human cognition, creating the Noösphere (from the Greek for mind) (Vernadsky 1927). In Cold War Russia, the anthropogenic geological time units were used (Shantser 1979). This was probably due to the fact that it is only a modest conceptual leap from the Marxist view of history to the concept that collective human agency would impact the environment on a global scale. The Holocene became the official term within the Geologic Time Series, embodying Charles Lyell's proposition that the current interglacial differs from the previous Pleistocene interglacials due to the influence of humans. We now know that modern humans have been around a lot longer than the Holocene (Maslin 2014).

We tend to think that the era in which politics and religion had a direct influence on scientific thought has past. However, Lewis and Maslin (2015a) gave a clear and stark warning to scientists that they must be aware that current political debates on the impact of capitalism and the global environmental crisis *could* strongly influence discussions on when the Anthropocene began. Indeed, scientific discussions over the beginning of the Anthropocene Epoch are clearly influenced by the wider political debate. The AWG was set up by the ICS in order to independently collate, assess and evaluate the evidence for the Anthropocene Epoch and its preferred start date. A working group would then be able to ensure that the rules of stratigraphy were followed and that undue political influences were avoided. However, there is some evidence to suggest the AWG is straying from this remit and could even be seen as an advocate group. In a number of publications by members of the AWG, a clear preference has been stated for the Anthropocene Epoch to be related to the 'Great Acceleration' (Zalasiewicz *et al*. 2015a; Steffen *et al*. 2015b; Waters *et al*. 2016). The Great Acceleration is the term coined to represent the suggested non-linear increase in human impacts after the 1950s

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(Steffen *et al*. 2015b). The AWG support for this view is despite the wide views concerning the start of the Anthropocene within the AWG itself. Table 1 in Lewis and Maslin (2015b) shows a straw poll of AWG members (C. Waters, pers. comm.) prior to the publication by Lewis and Maslin (2015a). It shows a wonderful diversity of ideas and views, not the general consensus that the key members of the AWG portray in publications (Zalasiewicz *et al*. 2015a, 2015b). One would expect the AWG to operate along similar lines to other major scientific committees such as the Royal Society working groups, the National Academies reports or the Intergovernmental Panel on Climate Change (IPCC). The IPCC collates the scientific evidence and publishes definitive tomes (2013/14). As a participant in the Anthropocene debate, my frustration is, given the wonderfully diverse nature of the AWG, why does it need to intervene in the debate on a regular basis in order to defend its own evolving position before it has reached a consensus (Zalasiewicz *et al*. 2015ba, 2015b)? This strategy seems to undermine a sense of the independence and credibility of the group and leaves it open to the criticism that it is playing politics with the definition of the Anthropocene Epoch. Shouldn't the AWG be focusing on how to collate and present the huge range of views for its recommendation report to the ICS, as this will have to go through extensive peer review for it to have any validity? As Lewis and Maslin (2015b) suggested, geoscientists should concentrate on defining the Anthropocene Epoch based on the rules of stratigraphy, and should *not* be distracted by the other wide-ranging and equally valid discussions on the history and politics of human impacts on the global environment.

AB: Your comments on the work of the AWG point to some of the limitations of dominant approaches to Science and Technology Studies (STS) that since the 1970s have focused on the process of knowledge production, including the study of laboratories, field research and exploration (see Powell 2007; Naylor and Ryan 2010). In recent years, STS researchers have been much less concerned with the political sociology of scientific institutions, such as the IUGS (cf. Blume 1974). But your remarks suggest that there is an urgent need to think not just about the concept of the Anthropocene, but also about the processes through which this concept is formally defined. The deliberations of the AWG raise a series of questions. To what extent should the AWG intervene collectively in the ongoing scientific debate about the Anthropocene? Why is it necessary to resolve the debate about the geological definition of the Anthropocene so rapidly, unless the debate is thought to have some political urgency? Who is included and who is excluded from the 'formal' debate about the Anthropocene, and on what basis, and through which mechanisms (Stengers 2009; Yusoff 2013a; Lövbrand *et al*. 2015)? And is the purpose of public presentations of the Anthropocene narrative by geoscientists merely to enable the public to understand the scientists' analysis, in order to influence global environmental policy (IGBP 2015)? Would it be possible to foster a different degree and form of public engagement that explicitly addresses both the technicality and the politics of the concept (cf. Callon *et al*. 2009; Born and Barry 2010; Whatmore 2013; Stirling 2014)?

MM: I'd agree that the process that may lead to a formal definition of the Anthropocene Epoch is highly political, and so will its implications be. But let me be clear that this shift in the scientific paradigm gives *a better* not just a different understanding of the world (Steffen *et al*. 2015b; Zalasiewicz *et al*. 2015a; Lewis and Maslin 2015a; Maslin and Lewis 2015). There is a common misinterpretation within the social sciences that paradigm shifts lend support to relativism. In this relativist view, science only has subjective value according to differences in perception, consideration or beliefs. Kuhn (1962, 1977) vehemently denied this, as would I, as the rational assessment of the weight of scientific evidence means the new paradigm is always superior to the previous theory. To be able to discuss and translate the new scientific concept of the Anthropocene, it needs to be defined. But which definition is taken will make a clear geopolitical statement: was it Neolithic farmers and deforestation, colonial expansion and the globalisation of biota, the industrial revolution and the use of fossil fuels, modern medicine and the great population explosion, capitalism and consumerism, or the development and testing of nuclear weapons that has accelerated and threatens planet-wide destruction? This is where geoscientists seem to encounter current politics for the first time, and unlike climatologists they do not have the experience of the last 25 years of discussing climate change to understand how to mediate these usually highly contested exchanges. This is a great shame because, in answer to your question, yes of course different forms of engagement with the public are required to discuss and in many ways legitimise the discussions of when humanity did in fact become a geological superpower. Just as the climate change and sustainability scientific communities have built new ways of public engagement, so should the AWG and others working on the Anthropocene.

AB: I agree, accounts of the Anthropocene should not be understood in relativist terms. They have been constructed from a wide range of evidence, from diverse sources, circumscribed by the rules of stratigraphy, and drawing on a range of traditions of thought from within, but also from beyond, geography and the geosciences (Latour 2013). If they are to be accepted,

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accounts of the Anthropocene have to be understood as constructs of historically contingent forms of scientific practice, not merely as *social* constructs or ideological projections (Stengers 2010). We agree on this; the science has to be rigorous. Nonetheless, as you make clear, the resolution of the controversy about the definition of the Anthropocene is in practice underdetermined by evidence, and may well remain so. Indeed, in your paper you give reasons for both the 'Great Acceleration (1964)' proposal and the 'Orbis (1610)' proposal; the Anthropocene boundary can reasonably be defined in several ways (see also Ruddiman *et al*. 2015). Leading members of the AWG appear to favour a date between 1945 and 1964 as a marker of the beginning of the Anthropocene, yet also acknowledge that there is a degree of arbitrariness to this date and a 'number of options' (Waters *et al*. 2016, 145). If the beginning of the Anthropocene is evidently underdetermined by evidence, should the formal debate about the concept of the Anthropocene really be confined within the geoscientific community as you suggest? Where you stress the distinction between the formal debate about the Anthropocene and the 'informal' debate that stretches across the social sciences, arts and humanities, I would argue that these debates should not be considered as clearly distinct in practice. My sense is that there are a series of intersecting vectors of disagreement that revolve both around the definition of the concept and the process through which the concept becomes formally defined.

MM: I don't see that this as a problem: the formal definition of the Anthropocene Epoch is not *the* only definition of the Anthropocene. In fact, it is the role of geologists officially to define geological time, and have the institutions that enable them to do so. But they have no ability, nor I would argue legitimacy, to define the beginning of historic periods or political systems. It is therefore incumbent on other subjects such as history, politics, anthropology, geography etc. to have their own definitions of the Anthropocene. Moreover, if the term Anthropocene is not fit for purpose within the disciplines, then other terms such as Capitalocene or Anglocene (Bonneuil and Fressoz 2013) should be used and defined. This also addresses the question of who should be involved in the discussion of the definition of the Anthropocene Epoch. Lewis and Maslin (2015b) suggest the AWG should review all contributions to this debate from all disciplines. But the recommendation they make in their final report to ICS should be based on the fundamental principles of stratigraphy and be able to be defended scientifically against accusations of political bias or agenda. If it does not follow these principles, it is very clear that the ICS will not ratify the Anthropocene Epoch. If a narrow geologically defined Anthropocene Epoch is agreed, then I suggest this would generate more debate and, indeed, it may push critical social scientists to re-evaluate their understandings of history.

AB: This returns us to the question, which has been posed by a number of critical social scientists. Namely, although Crutzen and Stoermer associate the idea of the Anthropocene with the impact of 'humanity's' activities, the idea that 'humanity' as a whole is responsible for the changes in the Earth system associated with the Anthropocene is problematic. The Orbis hypothesis directs us to the relation between the Anthropocene, colonialism and mercantile capitalism, while the 'Great Acceleration' hypothesis points to the connections between the Anthropocene, post-war consumer capitalism, and the geopolitics of the Cold War. Some have argued that the Anthropocene should be renamed the Capitalocene or, alternatively, the Anglocene (Bonneuil and Fressoz 2013, 134; Bonneuil 2015; Luke 2015; Moore 2015). But whichever of these terms are used, they all demand a focus on the relation between different accounts of the geology of the Anthropocene and economic and political history, including the history of capitalism and colonialism, as your paper suggests (see also Castree 2015). Humanity's impact on the Earth system, however it is conceived, has been uneven and unequal. The Anthropocene has been associated not just with the formation of global trade networks, but also with the history of colonial violence and appropriation, with 'war, enslavement and famine' (Lewis and Maslin 2015a, 175). These concerns remain, at best, on the margins of the formal debate about the Anthropocene: my question is should they? And if not, how can such an analysis be brought within the formal debate?

But there is also danger that the idea of the Anthropocene implies that the geological history of the Earth and the Earth system can be understood from a space outside of history and politics; in other words, the Earth becomes treated as a 'system whose mutual relations do not require the expression of the fact that they are thought about' (Whitehead 1920, 3). In Donna Haraway's terms, the Anthropocene turns out to be a view 'from nowhere' (Haraway 1991; Stengers 2009). The Anthropocene narrative appears to provide a singular, unified account of a global system at a moment when postcolonial and feminist theorists have questioned the idea that it is possible and even desirable to provide such an account (Gibson-Graham 1996; Chakrabarty 2000; Mitchell 2002; Chakrabarty 2015). In this respect, while there is a need to consider the relation between the history of capitalism and the Anthropocene, it is also worth noting the similarities between the concept of the Anthropocene and the concept of capitalism, and the parallels between the problems that both concepts pose and encounter. Is it possible, in particular, to construct a non-Eurocentric account of the Anthropocene? And

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rather than offer a singular account of the Anthropocene, might it be possible to address the ways in which all analyses of the Anthropocene are inevitably, or necessarily, partial?

MM: All these discussions are valid, but I would argue that they need to be underpinned by a scientific assessment of the human environmental and evolutionary impact on Earth and thus a 'geological' definition of the Anthropocene. Geologists are very practical and are only interested in defining stages within geological time that can be measured. Hence, the scientific evidence for us being within the Anthropocene Epoch is overwhelming whether we measure nitrogen fixing, ocean acidification, atmospheric carbon dioxide levels or biodiversity loss. Debates about who has caused these massive environmental impacts and why is the reason other academic subjects are vital to the study of the Anthropocene. Because it is clear that these massive alterations of the Earth system have been caused by predominantly a white European elite. This has even led to debates about the 'bad Anthropocene' with its gross inequalities and massive impacts juxtaposed with the alternative 'good Anthropocene' or even 'great Anthropocene' in which humans shrink their footprint, deal with global inequality and create more room for nature (Hamilton 2015). This then makes the concept of the Anthropocene an extremely effective political tool.

AB: I would agree with your last point, but in my view the question of the politics of the concept cannot be avoided. Moreover one challenge, which you raise, is how it is possible to review the contributions to the debate from disciplines beyond the geosciences. I'd argue that discussions of the relative merits of the different proposals for the formal definition of the concept should include wider contributions from environmental, economic and political history (e.g. Hornborg *et al*. 2007; Wrigley 2010; Mitchell 2011). This has hitherto not been the case. A second challenge is how to account for those human impacts on the Earth system that *cannot* be measured, and that are therefore not easily captured in a strictly geological definition of the Anthropocene. One problem with associating the Anthropocene with humanity's measurable impacts on the Earth system is that there are clearly many impacts that are not measurable. Indeed, the social sciences and humanities have long been concerned with the study of human interpretations and experiences, as well as with the associated realms of the aesthetic and the affective. In this way, the debate also raises the problem of how to conceive of those aspects of the Anthropocene that are unmeasurable (cf. Weszkalnys and Barry 2013). I am concerned that the debate ends up reproducing rather than challenging the existing division of labour between, on the one hand, the natural sciences, which primarily focus on what can be measured, and, on the other hand, those social sciences and humanities that are concerned, in part, with the unmeasurable. Rather than accept this division of labour, I would like to hold the different accounts together and in tension, while recognising their differences.

MM: My first response is that the concept of the Anthropocene fundamentally changes the relationship between the natural sciences and society. Adopting the concept of the Anthropocene reverses 500 years of scientific discoveries, which have continually demonstrated the insignificance of humanity. The Copernican revolution placed the Sun rather than the Earth at the centre of the cosmos, while modern cosmology suggests our Sun is one of 10^{24} stars in the Universe, each one with the potential to have planets. Darwin's nineteenth century discoveries and the development of evolutionary studies established that humans are merely twigs on the tree of life with no special origin. The adoption of the idea of an Anthropocene reverses this trend; humans are no longer passive observers of Earth. *Homo sapiens* play a central part in the future of the only place where life is known to exist. The concept of the Anthropocene suggests that humanity has become a geological superpower, and that power is reflexive and can influence both the environment and social structures either positively or negatively.

Again I stress that the concept of the Anthropocene bridges the gap between the natural and social sciences. We should, therefore, separate the argument for defining the Anthropocene Epoch from the more fluid and broader use of the Anthropocene concept. Because in many ways it does not matter which definition of the Anthropocene Epoch is chosen, because it is the debate and discussion within and beyond science about the human impact on the Earth System which is the true paradigm shift in our thinking. It is this shift in thinking which allows the real discussion of the role of humanity within the Earth system, which is something that can never be reduced to mere measurement. But I do raise a challenge, which is social scientists need to engage more fully in this debate. Because in many ways the Anthropocene is the perfect conceptualisation of what 'geography' as a subject has always represented and we need to build more constructive dialogues such as this one to move the debate along.

AB: One aspect of the disciplinary politics of the concept, which your remarks raise, is how the concept of the Anthropocene both reflects and potentially transforms the relations between the geoscientific disciplines. Certainly, it cuts across the division between human and physical geography (Harrison *et al*. 2004); but it's clear the concept of the Anthropocene also raises questions about the relations between the

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geosciences, in particular between geology and geochemistry, but also between the various other fields including biogeography and geomorphology, and Earth system science more broadly. The focus on the importance of geochemistry is, of course, central to the work of Validimir Vernadsky in the early twentieth century (Vernadsky 1927), whom you have already mentioned. One of the strong arguments you make in your paper is the significance of cross-continental movement of food and animal species that 'contributed to a swift, ongoing, radical reorganization of life on Earth without geological precedent' (Lewis and Maslin 2015a, 174). So could one say that the Anthropocene stretches the narrow meaning of the geo, to include both the chemical and the biological?

MM: That's right. But I would go yet further and argue that the different disciplines of geology, chemistry, and biology, as well as hydrology, climatology, oceanography and so on, have already been fused into what we term Earth system science. Earth system science addresses the interaction between the atmosphere, hydrosphere, lithosphere (or geosphere), biosphere and heliosphere. This new field emerged initially from the debate around the Gaia hypothesis developed by Lovelock and Margulis (1974). Their revolutionary idea was that life coevolved with the environment, so that biota influence their abiotic environment, and that environment in turn influences the biota through Darwinian processes. Examples given of life's ability to regulate the environment are salinity in the ocean, oxygen in the atmosphere, and global temperatures. Though the Gaia hypothesis has received much criticism, it did precipitate the development of a whole new field of science, namely Earth system science, as all agree that the biosphere has a huge influence on the Earth system, ranging from the speed of tectonic plate movements to the chemical composition of the atmosphere, and from the rate of mountain erosion to the intensity of the hydrological cycle (Wainwright 2009). In many ways, the concept of the Anthropocene is a natural extension of Earth system science because it acknowledges humanity as a major influence on both the biotic and abiotic environment. What I would ask of you is how does the concept of the Anthropocene influence the relationships between the different social sciences, including anthropology, geography, STS, history, and philosophy, given that the Anthropocene concept challenges each in its own way and also their relationship with the natural sciences?

AB: It's an important question though difficult to answer, because all of these fields are themselves already so interdisciplinary and fragmented (Barry and Born 2013). However, in broad terms, the Anthropocene concept has become part of a wider interdisciplinary conversation between geography, anthropology and STS. It poses the general question of how 'human' geography and social anthropology can and should consider what has been variously described as the force or agency of the non-human (Braun and Whatmore 2010)? But, at the same time, as Chakrabarty's influential essay suggested, it should provoke a wider conversation between geographers and historians about how we might rethink the role of the geo- in history and politics.

This brings me back to one of our central questions: how is it possible to think of the Anthropocene as a political concept? Part of the challenge in addressing this question is that although the notion of the Earth system appears to be a powerful one, stretching the meaning of the geo, Earth system science offers no account of politics or history. In this way, the concept of the Anthropocene both indicates the significance of Earth system science, and the challenges that it poses, but at the same time it also points to the limits of Earth system science as a field. Just as social scientists and historians have struggled to rethink the concept of capitalism, there is a need to rethink the notion of the Earth system in a way that addresses the politics of the concept and its limits.

MM: This is a challenge. But just by having the discussion, we are bringing the role of humans within the Earth system into our understanding of politics and history. Lewis and Maslin (2015a) reviewed all the potential human global impacts from the invention of fire through to the testing of nuclear bombs. Although only one of these many impacts can be selected as the boundary for the Anthropocene Epoch; the others provide a new understanding of our role as a force of nature. Moreover, do not be fooled by the discussions of applying the scientific principle to establishing the start of the Anthropocene, as they mask very strong individual political views: from those who believe that early agriculture was the start of global landscape change (Ruddiman *et al*. 2015), to those who see colonisation and the birth of capitalism as the start of the negative global environmental impacts (Lewis and Maslin 2015a), to those who see the massive increase in population and technology in the second half of the twentieth century as an acceleration of our negative global impacts (Waters *et al*. 2016).

Conclusion

One of the critical features of the geoscientific controversy about the Anthropocene Epoch is that it revolves around a series of technical and evidential questions about how to determine the boundary of a distinct 'human' controlled geological time unit. But at the same time, as we have stressed, it raises a series of political and conceptual questions regarding the relationship between geological and human history, as well as

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between the geosciences, geography and the environmental social sciences and humanities more broadly. We have not sought to resolve these questions, but rather to stage an encounter that cuts across the boundaries between the natural and social sciences and humanities. Whereas one of us (MM) has argued that the formal and informal debates about the Anthropocene should be kept distinct, the other (AB) has argued that this separation is proving both difficult to sustain in practice, and is problematic to maintain in principle. In effect, we differ on how to conceive and enact the relation between science and politics. Nonetheless, despite our differences, we would both argue that many of the questions raised in this paper have been insufficiently addressed within the geoscientific literature on Anthropocene. Although the idea of the Anthropocene has provoked critical debate across a range of fields, we are concerned that the diverse debates about the Anthropocene may end up reproducing existing divisions between the natural sciences, on the one hand, and the social sciences, humanities and arts, on the other. The Anthropocene may also turn out to be an anti-political concept: one that effectively reduces the potential space for disagreement. It will be a challenge to make sure that neither of these possibilities are realised.

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Note

1. At the International Geological Congress (IGC) in Cape Town South Africa on Monday 29th August 2016 the Anthropocene Working Group announced that there is enough evidence for defining an Anthropocene Epoch and the start date should be post-1950. They also suggested that it would take another 2 to 3 years of work to find a suitable GSSP (Golden Spike) to define the base of the Anthropocene Epoch. Only once the AWG have completed this work will it return to the IGC to ask for the Anthropocene Epoch to be formally ratified.

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