SCIENTIFIC METHOD / SCIENCE & EXPLORATION

For the second time, we are witnessing a new geological epoch

Welcome to the Anthropocene.

by **Annalee Newitz** - Jan 11, 2016 7:45pm EST

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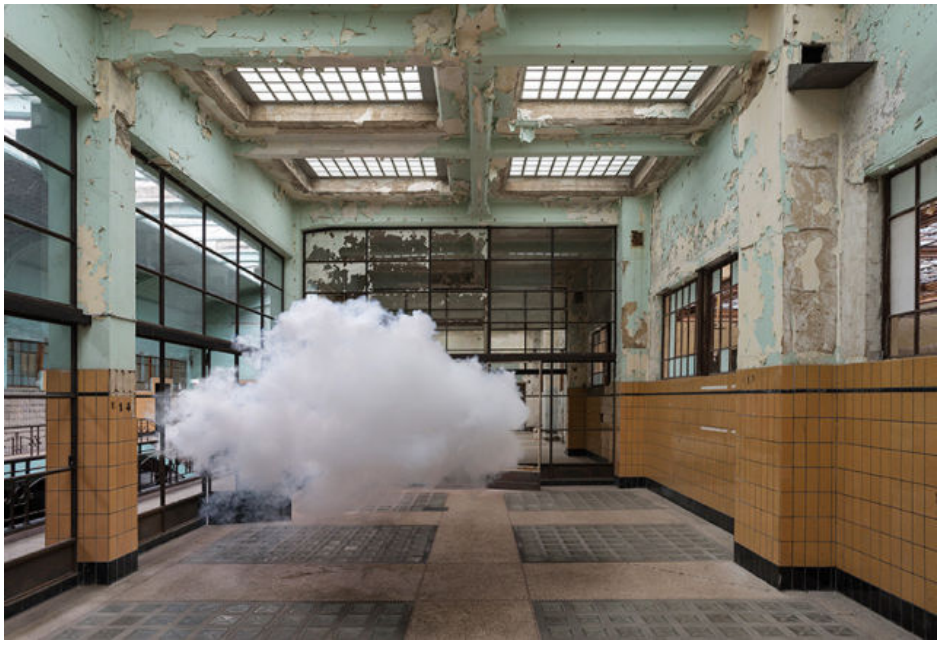

Artist Berndnaut Smilde imagines strange new climates of the Anthropocene by suspending clouds in the middle of rooms.

Berndnaut Smilde

11,700 years ago, the Earth suffered a catastrophic climate change. As the ice age ended, sea levels rose by 120 meters, the days grew warmer, and many kinds of plant and animal life died out. But one animal began to thrive more than ever before. *Homo sapiens,* which had already spread to every continent except Antarctica, came up with a new survival strategy. Today, we call it farming.

Thanks in part to that innovation, humans survived to witness the dramatic transition from the Pleistocene epoch to the Holocene—it was the first such geological transition in almost 2 million years. But now geologists say we're witnessing another transition, as we move from the Holocene into an epoch called the Anthropocene. Here's what that means.

Remember the Holocene

At the dawn of the Holocene 11,700 years ago, humans lived in nomadic groups, often returning to the same campsites year after year but always on the move. Still, there is evidence that they were dabbling with gardening opportunistically, perhaps leaving seeds behind at favorite campsites to encourage the growth of grain.

They already had domestic animals, too. Dogs fit in nicely with a hunter/gatherer lifestyle, and recent genetic analysis shows that humans and dogs have been living together for possibly as long as 30 thousand years. But as the weather changed and old haunts stopped yielding food naturally, it seems that our ancestors began to explore farming and animal domestication more methodically.

It still took a few thousand years for agricultural villages to spring up. Another weather catastrophe

called "a cooling event" struck the planet roughly 8200 years ago, marking the Middle Holocene and coinciding with what archaeologists call the Neolithic phase, or stone age, in human culture.

The cooler climate led to dry spells, and finding food must have become more difficult. So humans in the Mediterranean and southern China started building permanent houses next to their first crude attempts at agriculture, and eventually kept domesticated animals too. The very idea of a permanent settlement was a revolution in human thinking, and each new environmental challenge led to greater innovations in both tools and structural engineering.

The Upper Holocene, or most recent phase in the epoch, began with yet another prolonged period of cold, arid weather around 4200 years ago. Seeking greater food security, humans built even more agricultural villages and began working with metals. But we also erected the first cities, with massive monuments and intricate levels of social stratification that required weird new inventions like money and writing in order to keep track of everyone and everything.

In a paper published last week in *Science*, British Geological Survey scientist Colin N. Waters and many colleagues argue that the Holocene marked a turning point for humanity. After all, we'd spent roughly 180 thousand years living as hunter/gatherers before suddenly settling down and filling every continent with our farms, houses, and cities.

Now, however, we're at a new turning point that began about 70 or 80 years ago. Everything from the Earth's oceans and climate, to its very rocks and dust, has been affected. Using the most rigorous scientific evidence-gathering, Waters and his colleagues have determined that Earth has entered a new geological epoch. They call it the Anthropocene, or the age of human forcing. New geological phases are generally named when researchers identify some kind of global environmental alteration in the geological record, whether from an ice age or something truly exceptional like a megavolcano, mass extinction, or meteorite impact. And that forcing results in a wholesale environmental change.

In the Anthropocene, humans are the authors of that forcing. That makes this an unprecedented time in both human and geological history. Not only are we witnessing the dawn of a new geological epoch, but we made it happen.

The Age of Concrete and Technofossils

Getting a new geological time increment added to the official record is a long, involved process. Geologist Jan Zalasiewicz, who contributed to the *Science* paper, told me back in 2013 that research papers are just the beginning. "It has to be considered by the Subcommission on Quaternary Stratigraphy and then by the International Commission on Stratigraphy itself," he said. "And then, if it gets through that, it has to be ratified by the International Union on Geological Sciences." Currently, they're about halfway through the process. This year, the International Commission on Stratigraphy is set to hear a proposal about adding the Anthropocene to geological history.

To build a case among their fellow scientists, Waters, Zalasiewicz, and their colleagues approached the Anthropocene the way they would any other epoch in geological history. They searched the Earth for signs of dramatic atmospheric changes, new kinds of rock formations, changes in plant and animal life, and perturbations in long-term chemical reactions like the carbon and nitrogen cycles. What they discovered were changes to the Earth's surface that were remarkable.

In some cases, the changes rivaled transformations caused by the rise of atmospheric oxygen 2.5 billion years ago, or the meteorite impact that killed most dinosaur species 65 million years ago. Most of these changes could be traced back to the 1950s, also known as the Great Acceleration, when the booming economy led to an explosion in city building, scientific innovation, and human population growth. In a sense, the Great Acceleration is to the Anthropocene what the end of the ice age was to the Holocene.

And like the ice age, the Great Acceleration changed vast parts of the Earth's surface. As Waters and his colleagues explain in *Science*, the Anthropocene will leave indelible marks behind in the geological record:

> Recent anthropogenic deposits, which are the products of mining, waste disposal (landfill), construction, and urbanization, contain the greatest expansion of new minerals [in billions of years] and are accompanied by many new forms of "rock," in the broad sense of geological materials with the potential for longterm persistence. Over many millennia, humans have manufactured materials previously unknown on Earth, such as pottery, glass, bricks, and copper alloys ... Concrete, which was invented by the Romans, became the primary building material from World War II (1939–1945 CE) onward. The past 20 years (1995–2015) account for more than half of the 50,000 Tg of concrete ever produced, equivalent to ~1 kg m−2 of the planet surface.

In 10,000 years, there will be a distinct layer of these "new forms of rock." There will also be global deposits of plastic, which enter the geological record during the Great Acceleration and are likely to become what the researchers dub "technofossils" which endure for millennia. Further evidence for change comes from chemical signatures left in the Earth's crust and Arctic ice by airborne particles like black carbon, polyaromatic hydrocarbons, pesticides, and radioactive isotopes. These chemical markers are found all over the world, indicating the kind of global shift that geologists expect when one epoch gives way to another.

Researchers often use mass extinctions to set boundaries between geological periods, and today there is growing evidence that animals are going extinct at an elevated rate. A much-cited 2011 paper from *Nature* calls this the "sixth mass extinction" (in reference to the previous five mass extinctions that nearly wiped out life on Earth). It's so common for mass extinctions to be used as geological time markers that many of them are known simply by the name of the two periods they straddle: the dinosaur dieoff is called the K-T extinction, for "Cretaceous-Tertiary;" and the biggest mass extinction on Earth, which occurred 250 million years ago, is called the P-T extinction for "Permian-Triassic."

After the Anthropocene

Why bother going through such an enormous research undertaking simply to get a new epoch added to the stratigraphic record? The researchers argue that this is more than just another academic exercise. They call it "the first instance of a new epoch having been witnessed firsthand by advanced human societies," and suggest it has far-reaching implications for humans. Waters told *Ars* via email that this study is a reminder that we have changed the geological record—and we can change it again:

> To know that we, as a population of 7 billion people, can have such a rapid and global effect on so many signals that are being recorded in the geological deposits accumulating at present (of which climate change is but one) is important and goes beyond pure scientific debate. To observe that some of these signals have already peaked, for example radionuclides from fallout, black carbon and fuel ash particles, shows that there is also an opportunity to change the track of some, though not all of the trends, we have set in place.

The Anthropocene is like a geological accounting ledger, showing what humans have added and taken away from our environment. Some of what we've added has been harmful, some neutral. Understanding the difference could help future generations keep our ledger better balanced.

But there's also a slightly chilling aspect to naming this epoch after humanity. Does the Anthropocene only end when humanity has met its demise? Not necessarily, said Waters. Other factors could become more powerful than human forcing. A supervolcano might erupt, covering the planet in ash. A meteorite might smash into San Francisco, causing global megafires. Less dramatically, Earth's cyclical climate changes would eventually usher in a new ice age, which Waters explained might "significantly inhibit our continued global influence." But "it is possible our geoengineering of the planet may defer or cancel that expected glaciation."

"Ultimately," Waters said, "processes that greatly reduce human population are most likely to bring the Anthropocene to a close." In other words, our reign will not end until there are far fewer humans on the planet. The Anthropocene could end in natural disaster, plague, or even the colonization of space.

No matter how it ends, acknowledging the Anthropocene puts humans in their proper historical place. Instead of regarding humanity as some kind of aberration or unnatural development, Waters and his colleagues' definition of the epoch suggests that we are a force of nature. We have transformed the planet much the way ice ages and supervolcanoes have done for millions of years.

Humans are just the latest agent of change in a 4.5-billion-year-old record of massive changes. But what makes the dawn of the Anthropocene different is that we are capable of understanding exactly what's happening. That's either deeply depressing or deeply hopeful, depending on what comes next.

Science, 2016. DOI: 10.1126/science.aad2622 (About DOIs).

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