January 30, 2023

News and notes

Before going on to a discussion on the Anthropocene, here are some news items that I thought were interesting.

Research

- Stratigraphy research: Modelling parametric uncertainty in large-scale stratigraphic simulations.
- Research into rock weathering: How temperature-dependent silicate weathering acts as Earth's geological thermostat; behind a pay wall, Phys.org summary here.
- Chemical erosion research; Unravelling biotic versus abiotic processes in the development of large sulfuric-acid karsts; behind a pay wall, Phys.org summary here.
- Earthquakes, geophysics, and the structure of the Earth: Seismic reflection imaging of deep crustal structures using local earthquakes in the Kanto region, Japan.
- More geophysics: Earth's inner core rotating slower than surface; research articles here and here.
- Better than some of the stuff on the platform: Exploring TikTok as a promising platform for geoscience communication.

Plate Tectonics

- Monitoring plate movement: Eight-year catalog of deep short-term slow slip events at the Nankai trough based on objective detection algorithm using strain and tilt records.
- Ancient continents: The role of V-shaped oceans and ribbon continents in the Brasiliano/PanAfrican assembly of western Gondwana.
- Studying ancient plate collisions: Using discordant U-Pb zircon data to re-evaluate the El Paso terrane: Late Paleozoic tectonomagmatic evolution of east-central California (USA) and intense hydrothermal activity in the Jurassic Sierra Nevada arc.

Paleontology

- Arctic primates: Basal Primatomorpha colonized Ellesmere Island (Arctic Canada) during the hyperthermal conditions of the early Eocene climatic optimum; Phys.org summary here.
- Early amphibians: Triassic stem caecilian supports dissorophoid origin of living amphibians; Phys.org summary here.
- Alligator evolution: Ice Age effects on genetic divergence of the American crocodile (*Crocodylus acutus*) in Panama: reconstructing limits of gene flow and environmental ranges: a reply to O'Dea *et al.*; Eureka Alert summary here.
- New pterosaur species with hundreds of tiny hooked teeth discovered.

Glaciers and Climate Change

- Antarctic glacier research: Kill dates from re-exposed black mosses constrain past glacier advances in the northern Antarctic Peninsula; Phys.org summary here.
- Clouds and storms in climate modelling: The role of baroclinic activity in controlling Earth's albedo in the present and future climates.

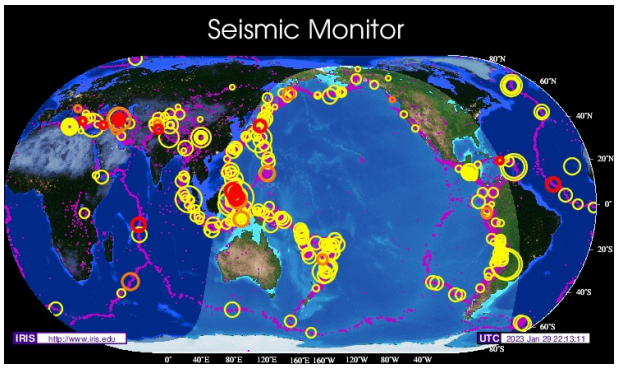
Environmental Geology and Hydrogeology

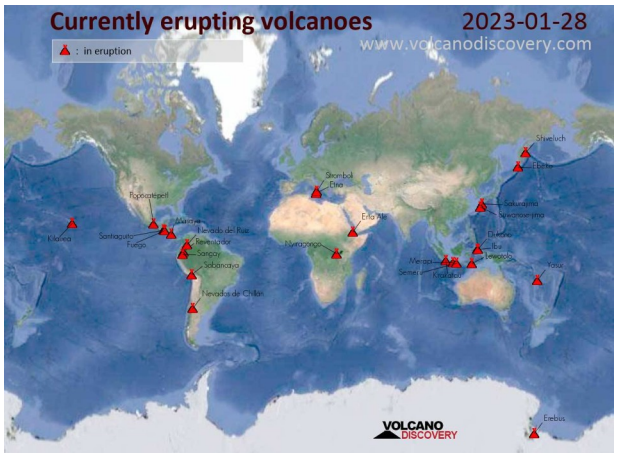
- Pollution and health: Increased night-time oxidation over China despite widespread decrease across the globe; Phys.org summary here.
- Water pollution: What Happens to Drugs After They Leave Your Body?
- Cleanup technology: Combining nanoscale zero-valent iron and anaerobic dechlorinating bacteria to degrade chlorinated methanes and 1,2-dichloroethane.
- LA's long, troubled history with urban oil drilling is nearing an end after years of health concerns.

Mining and Energy

- 'Timing is right' for NWT to harness critical minerals boom, says minister.
- Eight new mines or expansions in British Columbia worth investment of $4.9 billion.
- US blocks mining in parts of Minnesota, dealing blow to Antofagasta's Twin Metals copper project.
- Whoops: Rio Tinto has lost radioactive capsule in Australian desert: FT.
- An open database on global coal and metal mine production.
- Book review: Formation of Gold Deposits (Neil Phillips); behind pay wall, another review here.
- From the United States Energy Information Administration (USEIA): In the past 20 years, natural gas has displaced most coal-fired generation in Pennsylvania.
- U.S. Natural Gas Prices Crash By 7%.
- German Crude Oil Imports Rose 11% in 2022 As Crude Import Bill Doubles.
- Russian Oil Exports to India Could Hit New High In 2023.
- Commentary: Just Say No To Just Transition – Replacing Jobs That Don't Need to be Replaced with Taxpayer Subsidies.
- Commentary: Refuting the myth that just a small area of solar panels plus storage can power the world – Alex Epstein.
- A New Pathway To Create Scalable Perovskite Solar Cells; data on the mineral Perovskite here.

Volcanoes, Earthquakes and Geohazards





Seismic Monitor **Currently Erupting Volcanoes**

- Eruption sequence of the 2022 Hunga Tonga-Hunga Ha'apai explosion from back-projection of teleseismic P waves; Phys.org summary here.
- More on Hunga Tonga-Hunga Ha'apai: Tonga eruption increases chance of temporary surface temperature anomaly above 1.5 °C; behind pay wall, Phys.org summary here.
- New life at Hunga Tonga-Hunga Ha'apai, from the University of Colorado, Boulder: Rare Opportunity to Study Short-Lived Volcanic Island Reveals Sulfur-Metabolizing Microbes; Geology In summary here.
- Mass extinctions and volcanism: Mercury evidence from southern Pangea terrestrial sections for end-Permian global volcanic effects; Phys.org summary here.
- Earthquake research: Seismic Response of Nenana Sedimentary Basin, Central Alaska; behind a pay wall, Phys.org summary here.
- From the Oregonian newspaper: It's been 323 years since the last Cascadia Subduction Zone earthquake. How prepared are you for the 'Big One?'
- Earthquake-Induced Tsunamis in Western Greece (Ionian Sea and Western and Southern Peloponnese): Use of Tsunami Quantities, Impact and ITIS-2012 Intensities for Highlighting Susceptible Areas.
- Flooding: Evaluating Knowledge Gaps in Sea-Level Rise Assessments From the United States; Phys.org summary here.

Upcoming Events

- Seventh International Symposium on Arctic Research, March 6-10, 2023, National Institute of Polar Research, 10-3, Midori-cho, Tachikawa-shi, Tokyo 190-8518, Japan.

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The Anthropocene

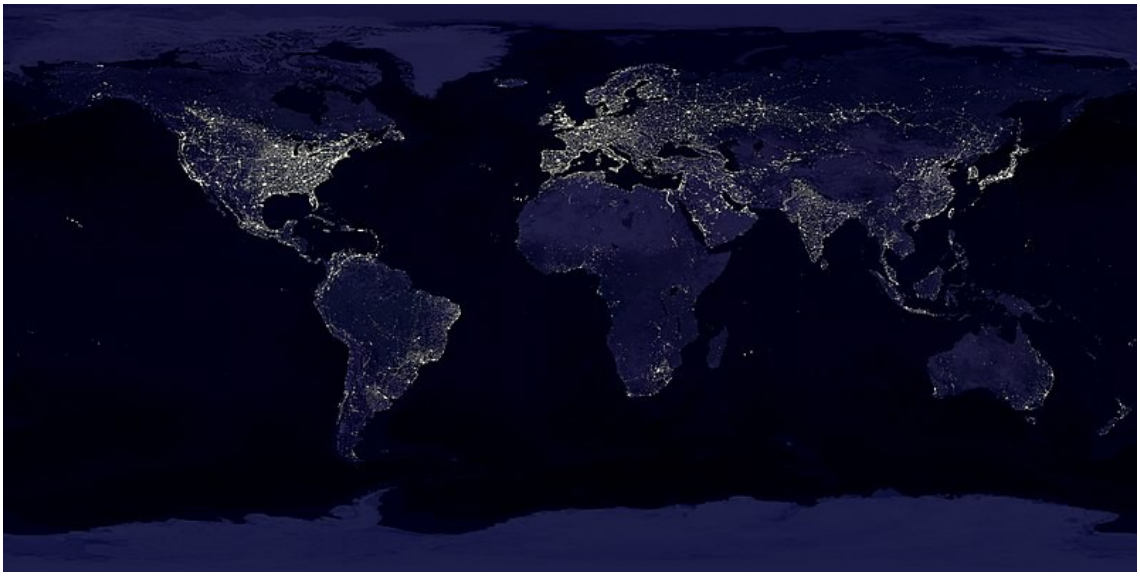

Figure 1 – Earth's City Lights
Credit: NASA Visible Earth, public domain

The Quaternary Period has sometimes been called the "Age of Man" in that it was during this period that humans became the dominant life form on the planet. However, some geologist think that we need to recognize our current times as a new geological epoch that they call the Anthropocene. Ecologist Eugene F. Stoermer and atmospheric chemist Paul J. Crutzen are credited with popularizing the term Anthropocene in May 2000 edition of the Global Change Newsletter (pp. 17-18) although the term appears to have been in informal use before then. The geological epoch has not been formally adopted by the International Commission on Stratigraphy (ICS). However, the Working Group on the 'Anthropocene' (AWG) is facilitating the debate on whether or not to formally define the current epoch as the Anthropocene Epoch. Some geologists question if the Anthropocene is really worthy of a formal geologic definition.

So let's look at the questions around the Anthropocene.

Naming the Anthropocene

When naming a new stratigraphic unit, the ICS requires the following:

- A clear and complete definition, characterization, and description of the unit so that any subsequent investigator can identify it.
- The proposal of the kind, name, and rank of the unit.
- The designation of a stratotype (type section) or type locality on which the unit is based and which may be used by interested scientists as a reference.
- Publication in a recognized scientific medium.

Lets look at these requirements.

Definition, Characterization and Description

Defining the Beginning of the Anthropocene

Since it was first popularized by Stoermer and Crutzen, there has been a lot of speculation on where to begin the Anthropocene. Among the suggestions:

- In 2003, William F. Ruddiman argued that the Anthropocene began approximately 8000 years before present (BP) with the development of agriculture;
- In 2020, Mark Maslin and Simon Lewis argued that the Anthropocene began with European colonisation, mass slavery and the 'great dying' of the 16th century;
- James Lovelock proposed in his 2019 book, *Novacene: the coming age of hyperintelligence*, that the beginning of the Anthropocene was the first application of the Newcomen engine (the predecessor to James Watt's steam engine) in 1712.
- The members of the AWG now favour using the beginning of the nuclear age, with the first detonation of an atomic bomb in 1945 at Alamogordo, New Mexico and the subsequent atmospheric tests that lasted till the Test Ban Treaty of 1963. The nuclear detonations resulted in the deposition of radioactive material from the fallout of the tests throughout the world.

Characterization

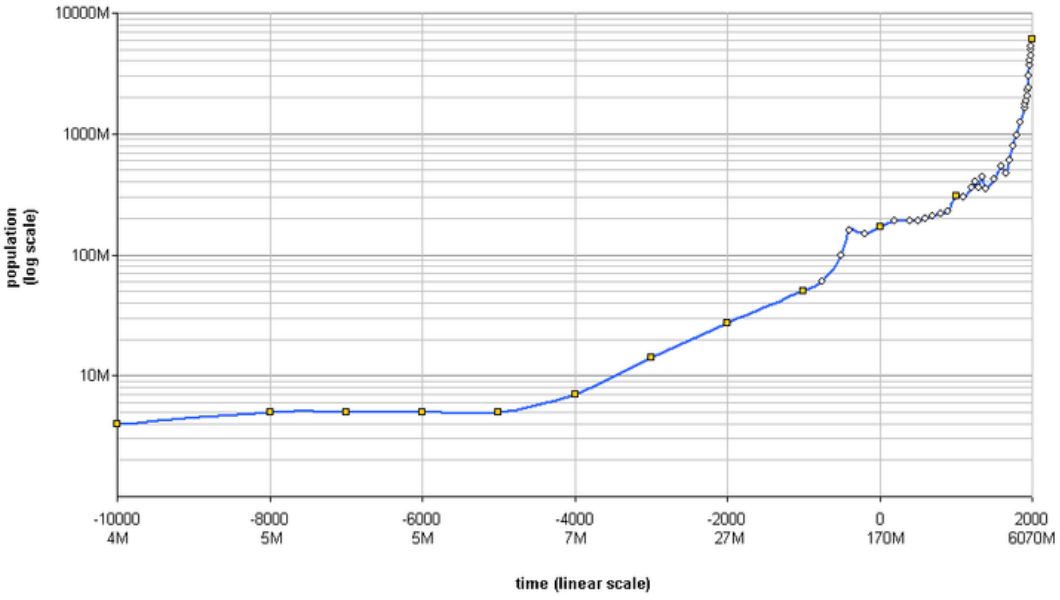

Figure 2 – Semi-log Graph of Human population from 10,000 BC to 2000 AD
Credit: Waldir, Creative Commons Attribution-Share Alike 3.0 Unported license

So characterizes the Anthropocene? These authors claim that the "The Anthropocene is functionally and stratigraphically distinct from the Holocene". Here are a few examples of why:

Human Population Growth. Figure 2, above, shows the growth of human population from 10,000 BC to the year 2000 AD. Even given the vagaries of fossilization, human remains will probably be common in sediments deposited during the current epoch.

Increased Erosion, Sedimentation and Moving Materials. Increased numbers of human beings means increased human activities and consequently increased erosion and sedimentation. Human activities shift ten times as much material on the Earth's surface as all natural geological processes put together.

Chemical Deposits: Sediments deposited during the Anthropocene, including glaciers, show the effect of burning coal, trace elements from a variety of human activities, radioactive isotopes from nuclear explosions, and microplastics in sediments.

Mass Extinctions. While difficult to accept, human activities have lead to, or been part of, the extinction of many plant and animal species. Humans were part of, but maybe not the only factor, in the Late Pleistocene Extinctions. In more recent times, humans have witnessed the extinction of numerous animals; this site lists 100 either from deliberate hunting or habitat destruction. Some people suggest that we are living through the Sixth Great Extinction.

This is by no means a comprehensive list of evidence for the Anthropocene. Follow the links to see more.

The Current AWG Proposal

The AWG is currently developing a proposal to formalize the Anthropocene. The website for the AWG lays out the following basis for the proposal:

1. *It is being considered at series/epoch level (and so its base/beginning would terminate the Holocene Series/Epoch as well as Meghalayan Stage/Age);*

2. *It would be defined by the standard means for a unit of the Geological Time Scale, via a Global boundary Stratotype Section and Point (GSSP), colloquially known as a 'golden spike';*

3. *Its beginning would be optimally placed in the mid-20th century, coinciding with the array of geological proxy signals preserved within recently accumulated strata and resulting from the 'Great Acceleration' of population growth, industrialization and globalization;*

4. *The sharpest and most globally synchronous of these signals, that may form a primary marker, is made by the artificial radionuclides spread worldwide by the thermonuclear bomb tests from the early 1950s.*

In 2019 the AWG agreed upon the following:

a) That the Anthropocene be treated as a formal chrono-stratigraphic unit defined by a GSSP; and

b) That the primary guide for the base of the Anthropocene be one of the stratigraphic signals around the mid-twentieth century of the Common Era.

Among the tasks for the AWG is to establish a GSSP or "golden spike" for the epoch; this will lead to the designation of a stratotype. Following this the AWG will publish a paper announcing the designation of the Anthropocene, or not. The current list of publications by the AWG is on their website (scroll down).

Winding it Up

So what do you think? I am still skeptical. The problem for me is that the time period proposed, 78 years since 1945 or 73 ears since 1950, is pretty short by geological standards.

The entire Quaternary Period, 11,700 years, is only 0.000251% of the entire world history of 4.65 billion years. The proposed Anthropocene, 78 years at most, is only 0.667 % of the Quaternary. Not a very long time.

Since the total time span for industrial civilization is likely to be short by geological standards, my opinion is that the Anthropocene will ultimately be a geological horizon or, depending on how industrial civilization ends, a bone bed of human remains. Not very optimistic but it seems to fit the evidence.

Standard Caveat

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.