March 27, 2023

News and notes

Before going on to discuss the Holocene Epoch, let's look at some some news items that I thought were interesting.

Research

- Petrology and plate tectonics: Pervasive hydrous carbonatitic liquids mediate transfer of carbon from the slab to the subarc mantle; Phys.org summary here.
- Rock mechanics: Determination of the crustal friction and state of stress in deep boreholes using hydrologic indicators; Phys.org summary here.
- Coastal geology in the Netherlands: The timing of decreasing coastal flood protection due to sea-level rise; Phys.org summary here.
- Coastal geology in Louisiana: Can biodiversity of preexisting and created salt marshes match across scales? An assessment from microbes to predators; Eureka Alert summary here.
- The early Earth: A mineral-based origin of Earth's initial hydrogen peroxide and molecular oxygen.

Paleontology

- Origin of eukaryotes: Nitrate limitation in early Neoproterozoic oceans delayed the ecological rise of eukaryotes; Phys.org summary here.
- 25-million-year-old fossils of a bizarre possum and strange wombat relative reveal Australia's hidden past; research articles here and here.

Environmental Geology and Hydrogeology

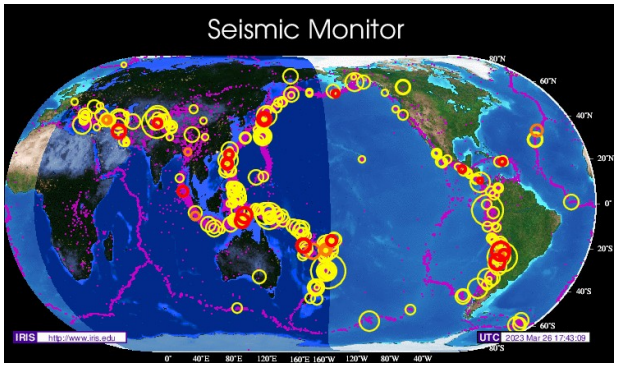
- As if Los Angeles doesn't have enough problems, from the L.A. Times: Scientists uncover startling concentrations of pure DDT along seafloor off LA coast.
- Sedimentation sifted out of pollution priorities; Phys.org summary here.
- Fertilizers can mobilize uranium into groundwater: Nitrate-Stimulated Release of Naturally Occurring Sedimentary Uranium; Eureka Alert summary here.

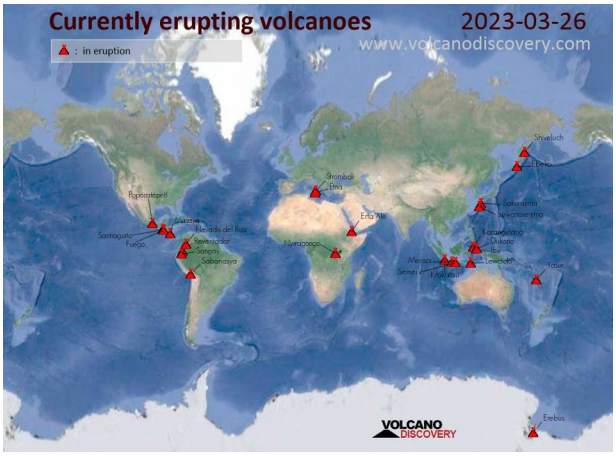
Mining and Energy

- Minimizing pollution from mining: Quantifying mercury use in artisanal and small-scale gold mining for the Minamata Convention on Mercury's national action plans: Approaches and policy implications; Phys.org summary here.
- Geology of ore deposits: Lithosphere architecture characterized by crust–mantle decoupling controls the formation of orogenic gold deposits; Phys.org summary here.

- More geology of ore deposits: Editorial: Further rare earth elements environmental dissemination: Observation, analysis, and impacts.
- LME nickel finally returns to regular trading hours after crisis; bags of rocks passed off as nickel bars.
- Lithium exploration: Victory's Highly Anticipated Drilling Program Starts at Smokey Lithium, Nevada.
- Exploration activity: U.S. drillers add oil and gas rigs for second week in a row – Baker Hughes.

Volcanoes, Earthquakes and Geohazards





Seismic Monitor **Currently Active Volcanoes**

- Japanese volcano research: Shallow resistivity structure around the 2018 craters of Mt. Motoshirane of Kusatsu-Shirane Volcano, Japan, revealed by audio-frequency magnetotellurics.
- Increasing complexity in magmatic architecture of volcanoes along a waning hotspot; Phys.org summary here.
- Japanese earthquake research: Examination of one-dimensional S-wave velocity structure using strong-motion data for high-seismic-intensity area during the 2018 Hokkaido Eastern Iburi earthquake and Blind study site assessment of shear-wave velocity at Kumamoto City, Japan, using direct-fitting SPAC methods.
- Disposal From In Situ Bitumen Recovery Induced the ML 5.6 Peace River Earthquake; Sanford University summary here.
- Australian earthquake research: Hypocenter, Fault Plane, and Rupture Characterization of Australian Earthquakes: Application to the September 2021 Mw 5.9 Woods Point Earthquake; Phys.org summary here.
- Landslide research: Application of environmental variables in statistically-based landslide susceptibility mapping: A review.

March 27, 2023

Life in the Holocene

In today's posting we'll recap the basics of the Holocene Epoch followed by a look at it's most important feature, the geological impact of humans. With this, we will wrap up our walk through the Geological Time Scale.

Summary of the Holocene

The Holocene is the geological epoch in which we live today. It is also the time that human beings grew to dominate the world's ecosystems. Geologists mark the beginning of the Holocene with the retreat of the Pleistocene glaciers approximately 11,650 years before present (BP) after the final major event of the Pleistocene, the Younger Dryas Event, that lasted from 12,900 to 11,650 years BP.

The Subcommission on Quaternary Stratigraphy of the International Commission on Stratigraphy has divided the Holocene into the ages or stages shown in Table 1

Table 1 – Divisions of the Holocene

Period	Epoch	Ages	YBP
Quaternary **2.58 Mya to Present**	**Holocene** **11,700 YBP to Present**	**Anthropocene?**	**?**
		Meghalayan	**4,200**
		Northgrippian	**8,276**
		Greenlandian	**11,700**

Based upon The Subcommission on Quaternary Stratigraphy

Humans a Geological Force During the Holocene

Modern humans, *Homo sapiens*, evolved from earlier (NOT LOWER) humans (hominins) during the Pleistocene Epoch. As with earlier forms, like *Homo erectus*, our ancestors were apex predators, that is, they were at the top of the food chain.

In looking back at our ancestors, it is clear that natural selection ruthlessly winnowed out the less fortunate. Better hunters and gatherers were better able to provide for their children and thus their

offspring thrived. Even marginal advantages had big effect over time, especially when those times were hard. The winners were those who were smarter, better team players, made better tools, had greater disease resistance, and had any of a number of traits that benefited their descendants. The consequence of this process was the development of a creature that was highly intelligent, made and used tools, was highly sociable and was capable of exploiting a wide range of food sources. Those who were not so able, died off, either directly or by leaving fewer and fewer offspring. The children of poorer hunters and gatherers would be more likely to die during times when food resources were scarce. People who were not optimally sociable would be ostracized, or simply killed for being arrogant pricks. People, especially women, chose partners based on proven abilities. Life was hard, and even harder if you were stupid, antisocial, or incompetent. The selection process worked not only on the individual level, but also at the group level: more successful groups out-competed, drove off or just eliminated less competent groups. This process began millennia ago and continues to this day.

The result of the process outlined above was the creation of a creature, our ancestors, that had amazing abilities when compared to other apex predators. And yet, they were thin on the ground. Human populations varied in response to available food resources but the best estimate for the number of humans at the beginning of the Holocene is around 4 million. In the grand scheme of things, just another large mammal.

So what happened?

At the end of the Pleistocene, perhaps in response to the Younger Dryas Event, some people began to change how they exploited plants and animals. People began the deliberate planting of food crops and nurtured prey animals for later use. In short, they developed agriculture.

The exact details of the origin of agriculture are lost in history. However, the growth of agriculture, and the subsequent development of complex, state level societies, led to the following large scale effects in the world:

- The stupendous growth of human population over the past 10,000 years;
- The wide-scale appropriation of land to feed the population, at the expense of pre-existing ecosystems; and
- The excavation and movement of increasing amount of material from the earth.

Let's quickly unpack these

Human Population Growth

Figure 1, below, shows the growth of human population over the past 12,000 years, based upon best estimates (check the data sources in the link). Looking at the graph we can see the following pattern:

- Population growth was slow at first; early village life provided ample opportunities for disease transmission, thus limiting population growth.
- Better technologies and organization led to an overall world population of just under 1 billion in 1800 AD; this was the last time we ran our world almost entirely on solar power.

- The beginning of the industrial revolution, increased both the ability to grow more food and transport it around the world.
- The process of increasing energy use leading to increasing human population really took off with the development of petroleum sources.
- Finally, the invention of the Haber-Bosch-process and the development new varieties of cultivars, the so called "Green Revolution" led to the current population of around 8 billion.

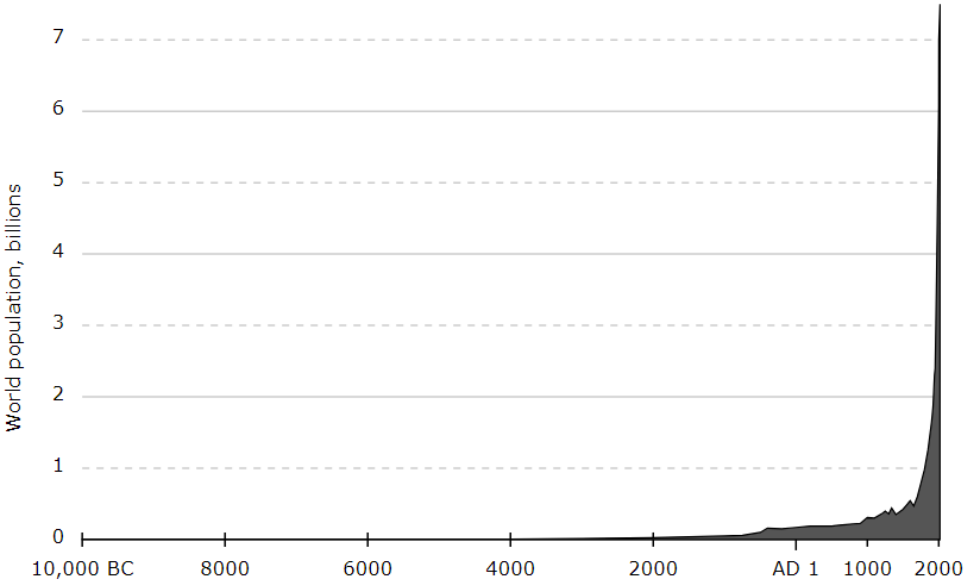


Figure 1 – World Population Since 10,000 BC
Credit: El T, public domain

Growth in Land Used for Agriculture

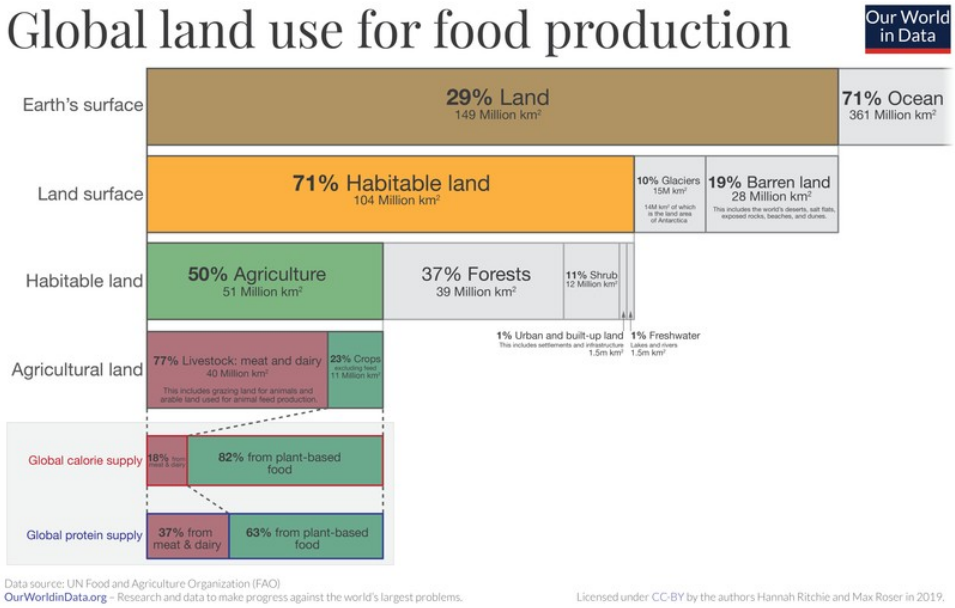


Figure 2 – Global Land Use for Food Production
Credit: H. Ritchie and M. Roser, Creative Commons Attribution-Share Alike 4.0 International license

The statistics are staggering, human use of the world's surface has grown from a few locations in the Fertile Crescent, China, Meso-America, Peru, Africa and New Guinea to every possible plot of arable land in the world. This is an unprecedented situation in the Phanerozoic Eon, perhaps the nearest analogy is the growth of cyanobacteria during the Proterozoic.

Use of Mineral Resources

Figure 3 – Open Pit Iron Mine, Marmora, Ontario
Credit: Community Archives, Creative Commons CC0 1.0 Universal Public Domain Dedication

Mines and quarries are the source for a huge amount of material for our industrial society. The British Geological Survey has stated that:

"*Humans now have a greater effect on shaping the surface of the Earth than natural processes do. Humans move about 24 times more material around the surface of the planet than rivers move sediment to the oceans*.".

Humans have become a geological force.

Wrapping it Up

That's it for the Holocene and for our walk through the Geological Time Scale that began with our look at the Hadean in October 2021. It's been quite a journey and I hope that you learned as much as I did in putting this together.

I am not sure what I will do for next week's posting. I may simply stick to news and notes until I come up with a new theme or I might think up something new. Join me next week and find our!

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.