January 2, 2023

News and notes

New Year's Fireworks
Credit: Adam.J.W.C., Creative Commons Attribution 3.0 Unported license

Happy new year everyone! Before going onto the beginning of our look at the Quaternary Period, here are some news items that I thought were interesting.

Research

- Accidental crystallization of a mineral: Electrical discharge triggers quasicrystal formation in an eolian dune; Phys.org summary here.
- Plate tectonics: Greenstone burial–exhumation cycles at the late Archean transition to plate tectonics.
- More plate tectonics: Late Miocene to recent tectonic evolution of the Macquarie Triple Junction.
- Zircon-modeled melts shed light on the formation of Earth's crust from the Hadean to the Archean: COMMENT
- From SciNews: Researchers Find Two Extraterrestrial Minerals in El Ali Meteorite; link to video presentation.

- Research in the Canadian Arctic: A Multi-proxy Provenance Study of Late Carboniferous to Middle Jurassic Sandstones in the Eastern Sverdrup Basin and Its Bearing on Arctic Palaeogeographic Reconstructions.

- Death Valley: Stratigraphy of the Eocene–Oligocene Titus Canyon Formation, Death Valley, California (USA), and Eocene extensional tectonism in the Basin and Range.

Paleontology

- End Cretaceous extinctions: Shifts in food webs and niche stability shaped survivorship and extinction at the end-Cretaceous; Phys.org summary here.

- Supper time for dinosaurs: Generalist diet of *Microraptor zhaoianus* included mammals; Phys.org summary here.

Glaciers and Climate

- Melting glaciers in Tibet: South Asian black carbon is threatening the water sustainability of the Asian Water Tower; Phys.org summary here.

- More melting glaciers: Ocean variability beneath Thwaites Eastern Ice Shelf driven by the Pine Island Bay Gyre strength; Phys.org summary here.

- The Bering Strait was flooded 10,000 years before the Last Glacial Maximum; Phys.org summary here.

Environmental Geology and Groundwater

- Arsenic remediation: Critical Perspectives on Soil Geochemical Properties Limiting Arsenic Phytoextraction with Hyperaccumulator *Pteris vittata*.

- Pollution and sedimentation: Can a Sediment Core Reveal the Plastic Age? Microplastic Preservation in a Coastal Sedimentary Record; Phys.org summary here.

- A 3D geomodel of the deep aquifers in the Orléans area of the southern Paris Basin (France).

- Groundwater depletion in California's Central Valley accelerates during megadrought; Phys.org summary here.

Mining and Energy

- Geology of a mineral deposit: Timing of Rhyolite Intrusion and Carlin-Type Gold Mineralization at the Cortez Hills Carlin-Type Deposit, Nevada, USA.

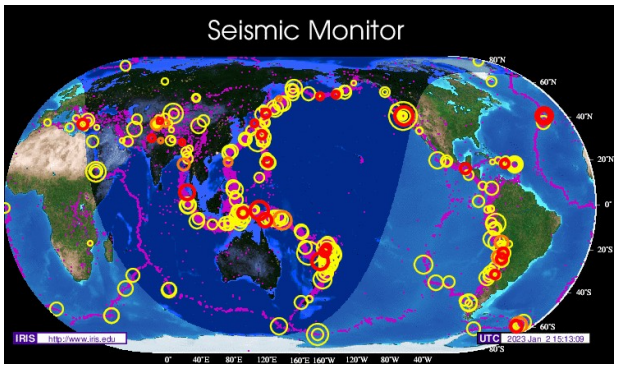
- From Mining.com: LME ends chaotic year with metal stockpiles perilously low.

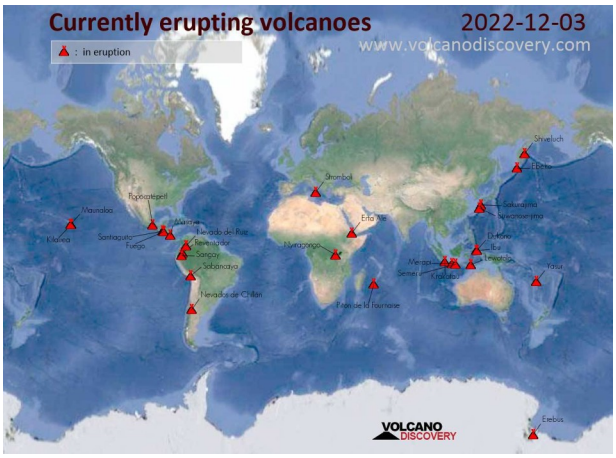
- Child miners: Joe Rogan interview with Siddharth Kara on cobalt mining in the Congo.

- From the United States Energy Information Administration (USEIA): U.S. refined coal production and consumption declines with the expiration of a tax credit.

- Also from the USEIA: U.S. nuclear electricity generation continues to decline as more reactors retire.
- 2022 Year-End Energy Review – A Year of Disruption – Deidra Garyk.
- Energy & geopolitics: Putin says Russia now one of China's leading oil and gas suppliers.
- Russia To Export Large Volumes Of Diesel Before EU Sanctions.
- Good news: Keystone Pipeline Restarts.
- Oilfield research: A New Look to the Heletz–Ashdod Oil Field (Southern Israel): A Non-Conventional Hydrocarbon Deposit in the Easternmost Mediterranean.

Volcanoes, Earthquakes and Geohazards





Seismic Monitor Link **Active Volcano Link**

- The Qixiangzhan eruption, Changbaishan-Tianchi volcano, China/DPRK: new age constraints and their implications.
- Volcanoes and earthquakes: The magmatic web beneath Hawai'i; Phys.org summary here.
- Earthquake prediction: A Kinematic Model of Quaternary Fault Slip Rates and Distributed Deformation at the New Zealand Plate Boundary; Phys.org summary here.
- Earthquake warnings: California earthquake puts early warning system to the test.
- Happy new year California: M 5.4 Earthquake in Northern California.
- Special issue publication: Kurile arc subduction zone: View of great earthquake generation and disaster mitigation of related phenomena.
- Geohazards: Machine learning-based tsunami inundation prediction derived from offshore observations; Phys.org summary here.

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The Quaternary Period – Overview

Period	Epoch	Ages	Mya
Quaternary 2.58 Mya to Present		Anthropocene?	
	Holocene 11,700 YBP to Present	Meghalayan	0.0042
		Northgrippian	0.0083
		Greenlandian	0.0117
	Pleistocene, 2.58 to 0.0117 Mya	Late Pleistocene	0.1290
		Chibanian	0.7740
		Calabrian	1.8000
		Gelasian	2.5800

Table 1 – Geological Timescale for the Quaternary Period
Credit: Based upon the Subcommission on Quaternary Stratigraphy

The Quaternary Period, also called the Ice Age or the Age of Man, is the current period in the Geological Time Scale. We'll be looking at the Quaternary over the next few weeks. There is a lot on the period so we could be looking at the Quaternary in many postings.

In this week's posting, we'll look at the main divisions of the Quaternary: the Pleistocene Epoch and the Holocene Epoch. In the next few weeks we'll take a closer look at the events of the period, the division between the Holocene and Pleistocene, especially the Younger Dryas Event, and the issue of whether or not we have entered a new period, the Anthropocene. Later, we'll look at all the neat fossils from the period.

The Pleistocene Epoch

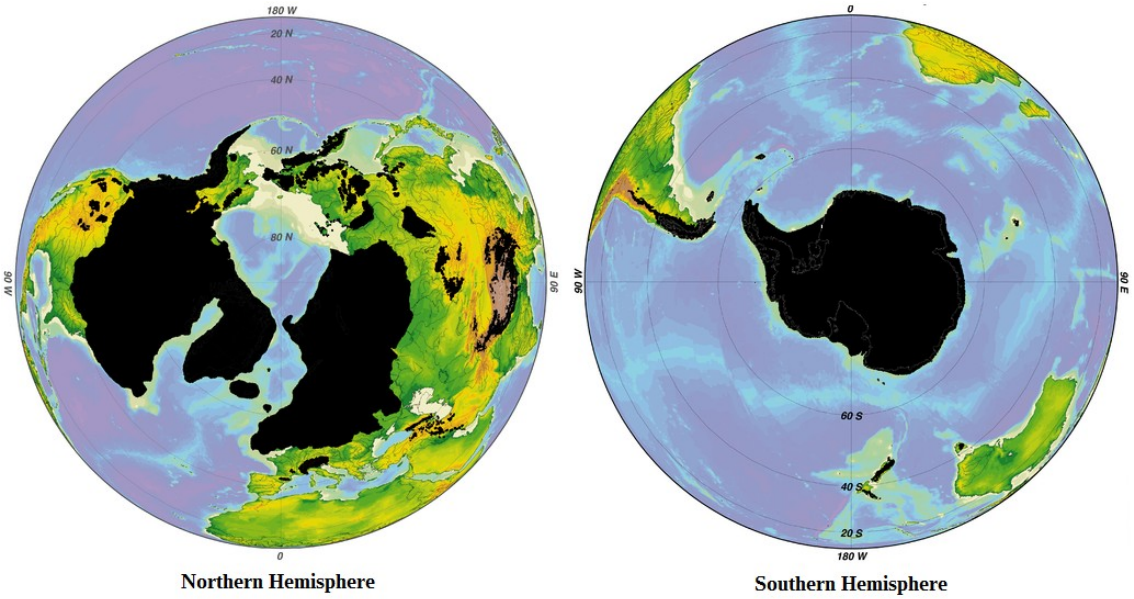


Figure 1 – Maximum glaciation (black) during the Quaternary climatic cycles
Credit North and South: Hannes Grobe/AWI, Creative Commons Attribution 3.0 Unported license

The Pleistocene Epoch lasted from 2,580,000 to 11,700 years ago. Charles Lyell first proposed the name in 1839 to describe formations he found in Sicily and that he thought were fairly recent in age. The Pleistocene was marked by a series of glaciations interspersed with interglacials.

The Subcommission on Quaternary Stratigraphy of the International Commission on Stratigraphy has divided the Pleistocene into four ages (chronological units) or stages (stratigraphic units):

- The Late Pleistocene;
- The Chibanian;
- The Calabrian; and
- The Gelasian.

We'll look at these ages from oldest to youngest.

The Gelasian Age

Named after the Sicilian city of Gela, the Gelasian age is the oldest subdivision in the Pleistocene and it lasted between 2.58 and 1.8 Mya (million years ago). Magneto-stratigraphy (past changes in the Earth's magnetic field) was used to define the base of the Gelasian at the Gauss-Matuyama magnetostratigraphic

boundary), isotopic stage 103. Nanofossils *Discoaster pentaradiatus* and *Discoaster surculus* appear to have gone extinct at this time. The Global boundary Stratotype Sections and Points (GSSP) for the Gelasian age is near Gela, Italy.

Figure 2 – GSSP of the Gelasian Age
Credit: M.J. Head, Subcommission on Quaternary Stratigraphy

The Calabrian Age

Lasting between 1.8 Mya and 774,000 years ago, the Calabrian Age was named after the Italian province of Calabria. The magnetic polarity chronozone C2n (also called Olduvai) marks the beginning of the Calabrian. The nanofossil *Discoaster brouweri* and *Globigerinoides extremus* are not found above this boundary while the earliest examples of the genus *Gephyrocapsa* begin to show up. The GSSP for the Calabrian is the Vrica section near Crotone, Calabria.

Figure 3 – The Vrica section near Crotone, Calabria, southern Italy
Credit: Ilka Von Dalwigk, Subcommission on Quaternary Stratigraphy

The Chibanian Age

Named after the Chiba Prefecture in Japan, the Chibanian Age lasted from 774,000 to 129,000 years ago. Also called the Middle Pleistocene, the GSSP of the Chibanian is the base of the Byk-E tephra bed found

on the Boso Peninsula of east-central Japan. The boundary also marks a geomagnetic reversal, the Brunhes–Matuyama reversal.

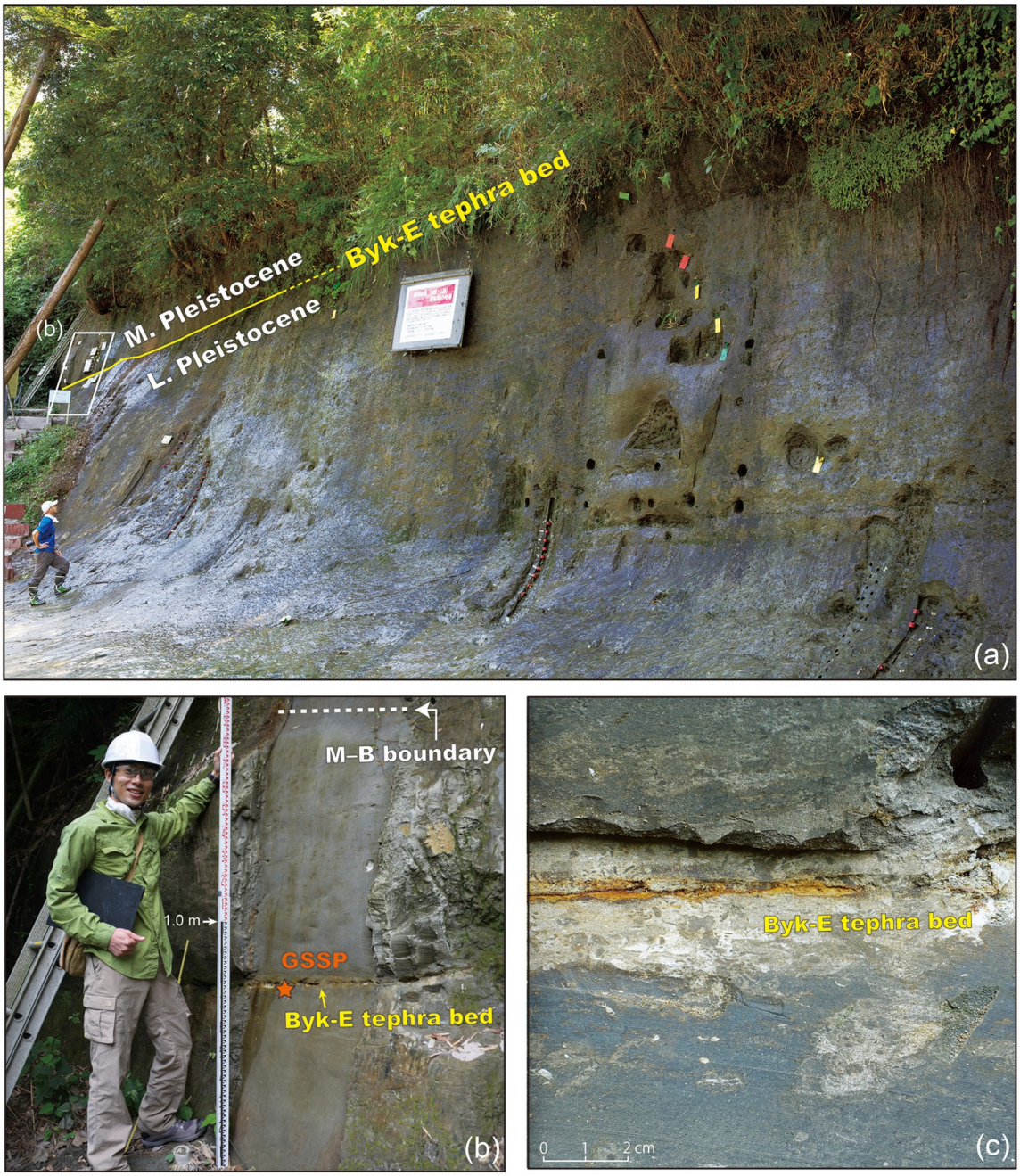


Figure 4 – The Chiba section, Chiba Prefecture, Japan – the GSSP for the Chibanian
Credit: M.J. Head, Subcommission on Quaternary Stratigraphy

The Late Pleistocene

An unofficial name, the Late Pleistocene lasted from 129,000 to 11,650 years ago. The bottom of the Late Pleistocene is generally taken as the beginning of the Eemian Interglacial Period which corresponds to Marine Isotope Stage 5. The Subcommission on Quaternary Stratigraphy has not defined a GSSP for the Late Pleistocene although there are two candidates:

- The Fronte Section, near Taranto, Apulia, southern Italy; and
- The EPICA Dome C ice core in Antarctica

In Europe, the term Tarantian, from Taranto, Italy, is used for the stratigraphic stage encompassing the Late Pleistocene and the British Geological survey considers it a chronological age although the Subcommission on Quaternary Stratigraphy has not approved of a name for the stage/age. It's a work in progress.

The Holocene Epoch

Figure 5 – Holocene Earth
Credit: NASA, public domain

The Holocene is the geological epoch in which we live today. 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.

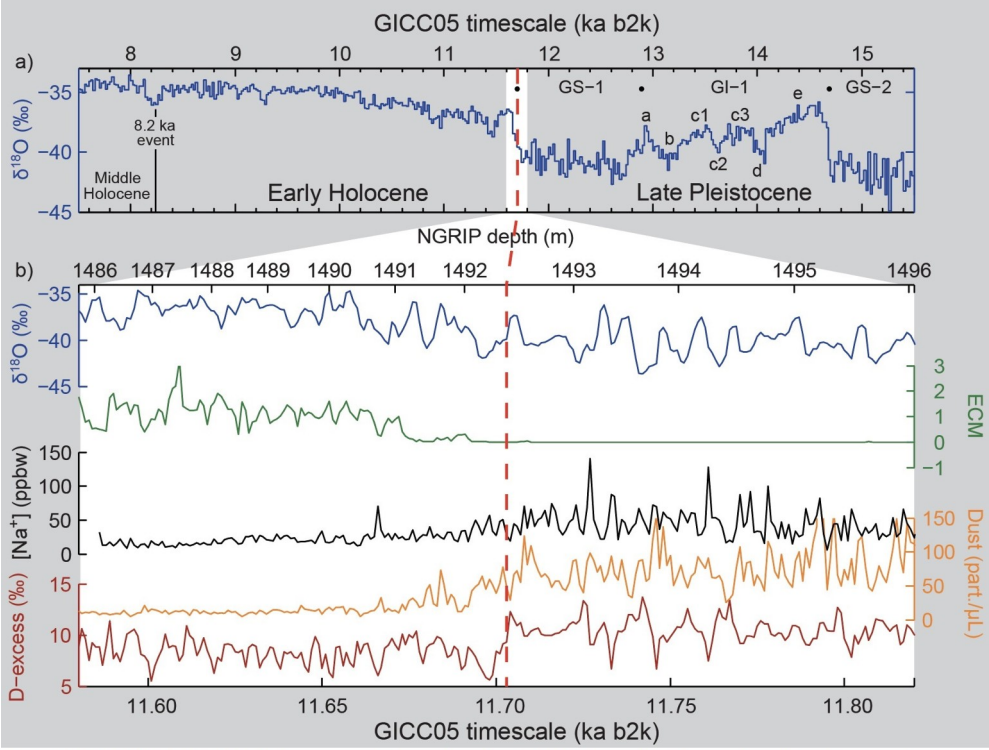
French zoologist and paleontologist Paul Gervais coined the term Holocene, first using it publicly in 1881 at the Second International Geological Congress (2nd IGC). Prior to the 2nd IGC, geologists commonly used Charles Lyell's designation for the time, Recent.

The Subcommission on Quaternary Stratigraphy of the International Commission on Stratigraphy has divided the Holocene into three ages or stages:

- The Meghalayan;
- The Northgrippian; and
- The Greenlandian.

Lets look at these ages from oldest to youngest.

The Greenlandian Age



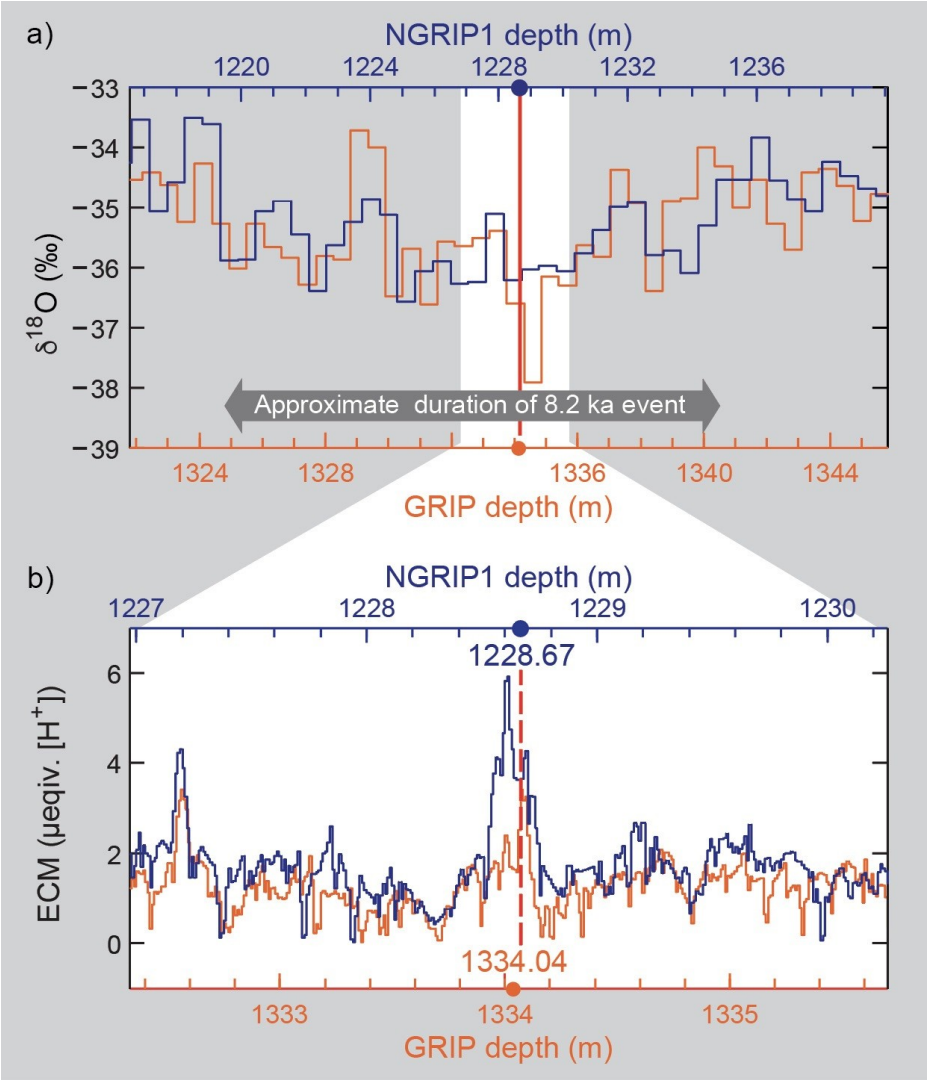
NorthGRIP2 (NGRIP2) ice core, Greenland – GSSP for the Greenlandian Stage, Lower Holocene Subseries, and Holocene Series. a) shows the oxygen isotope record across the Pleistocene–Holocene boundary, and b) high-resolution multi-parameter record: δ18O, electrical conductivity (ECM), Na+ concentration, dust content, and a sharp decline in deuterium excess at the GSSP indicating rapid warming.

Figure 6 - Record from the NorthGRIP2 ice core from central Greenland
Credit: Figure 5 in Walker *et al*, 2019

The Greenlandian Age began approximately 11,650 BP and lasted till 8,276 BP. Named after Greenland, and the North Greenland Ice Core Project (NorthGRIP). The GSSP for the Greenlandian age is from the 1492.45 m depth of the NorthGRIP (NGRIP)2 ice core from central Greenland: 75.10°N, 42.32°W. The

geochemistry of the 1492.45 m depth of the NGRIP2 ice core clearly showed a change in the global climate at that time.

The Northgrippian Age



NorthGRIP1 (NGRIP1) ice core, Greenland – GSSP for the Northgrippian Stage and Middle Holocene Subseries. a) shows the water oxygen isotope record in both GRIP and NGRIP1 Greenland ice cores, where the arrow marking the 8.2 ka climate event has a duration from ~8300 a b2k (1234.78 m) to ~8140 a b2k (1219.47 m). b) Electrical conductivity measurements (ECM) reveal a distinct acidity double peak, most probably caused by an Icelandic volcano. This peak is dated on the GICC05 timescale to 8236 a b2k (8186 cal a BP), and is the primary marker for the GSSP which is indicated by the dashed vertical line

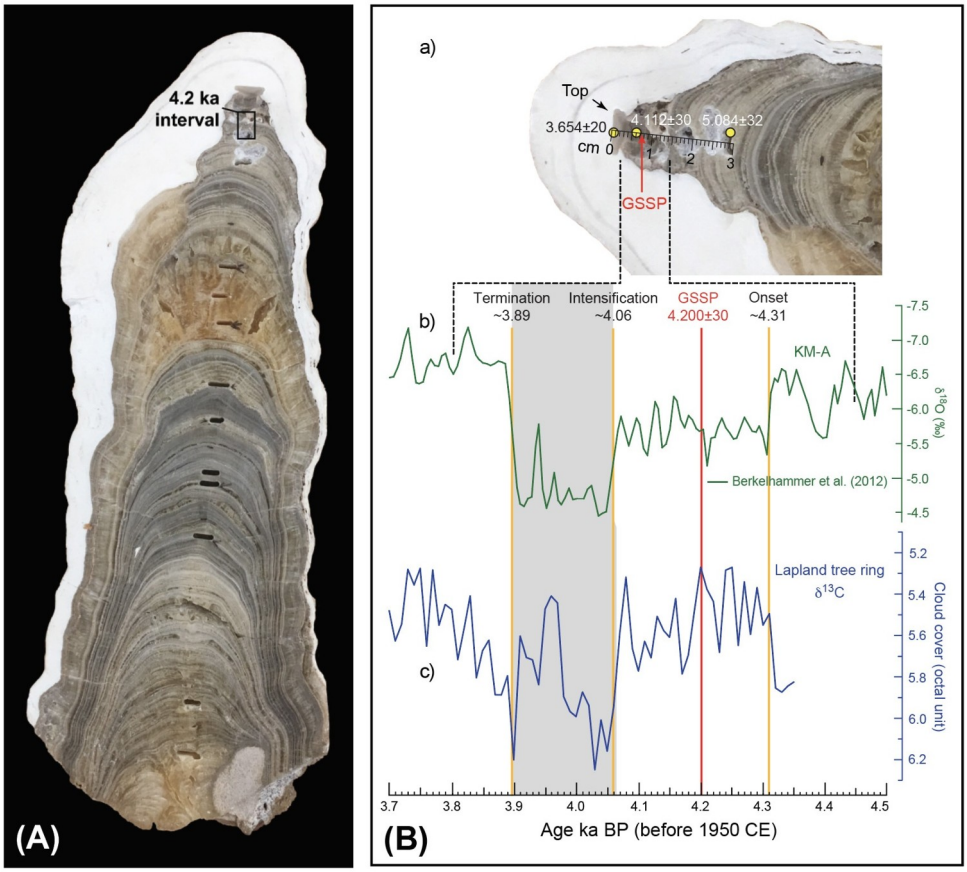
Figure 7 – Record from the NorthGrip1 Ice Core
Credit: Based upon Walker *et al* 2012, 2018, 2019

Named after the North Greenland Ice Core Project, the Northgrippian lasted from 8,276 years BP until 4,200 years BP. The Northgrippian Age covers the time of the 8.2 kiloannum (ka) climatic event. The event appears to have occurred as the result of an interruption of North Atlantic Deep Water formation by

catastrophic meltwater release from glacial lakes Agassiz and Ojibway into the North Atlantic during melting of the Laurentide Ice Sheet, together with meltwater contributions from elsewhere.

The GSSP for the Northgrippian is from the NGRIP1 ice core from central Greenland, 75.10°N, 42.32°W at 1228.67 m depth.

The Meghalayan Age



Speleothem KM-A from the Mawmluh Cave, State of Meghalaya, India – GSSP for the Meghalayan Stage and Upper Holocene Subseries. A) the speleothem KM-A with the position of the 4.2 ka climate event which is the primary guide to the GSSP. The speleothem is ~308 mm long. B) a) precise location of the GSSP, b) Oxygen isotope record of speleothem KM-A across the GSSP interval showing the precise position of the GSSP. The GSSP occurs at the approximate mid-point between the onset of the 4.2 ka climate event and its intensification (marked by the shaded rectangle). c) an inverted δ13C tree ring record from northern Finland as a proxy for wetter conditions, and the most northerly expression yet documented for the 4.2 ka event

Figure 8 – The GSSP of the Meghalayan Age
Credit: Based on Figure 5 in Walker *et al*, 2019, and Figure 12 in Head, 2019

The Meghalayan Age is the current age of Holocene and began 4,200 years BP and continues to present. The beginning of the Meghalayan corresponds to the 4.2 ka Event, a period of increasing aridity and consequent famine among the earliest human civilizations. It is named after the State of Meghalaya in northeastern India

The GSSP for the Meghalayan Age is the 7.45 mm depth in speleothem (stalagmite) KM-A (Head, 2019) from a cave near Mawmluh Cave, near the town of Sohra (Cherrapunji), State of Meghalaya, northeastern India.

Wrapping it Up

We'll go deeper into the events of the Pleistocene and Holocene in future postings. Next week we'll take a look at the events of the Quaternary and especially the Pleistocene glaciations.

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.