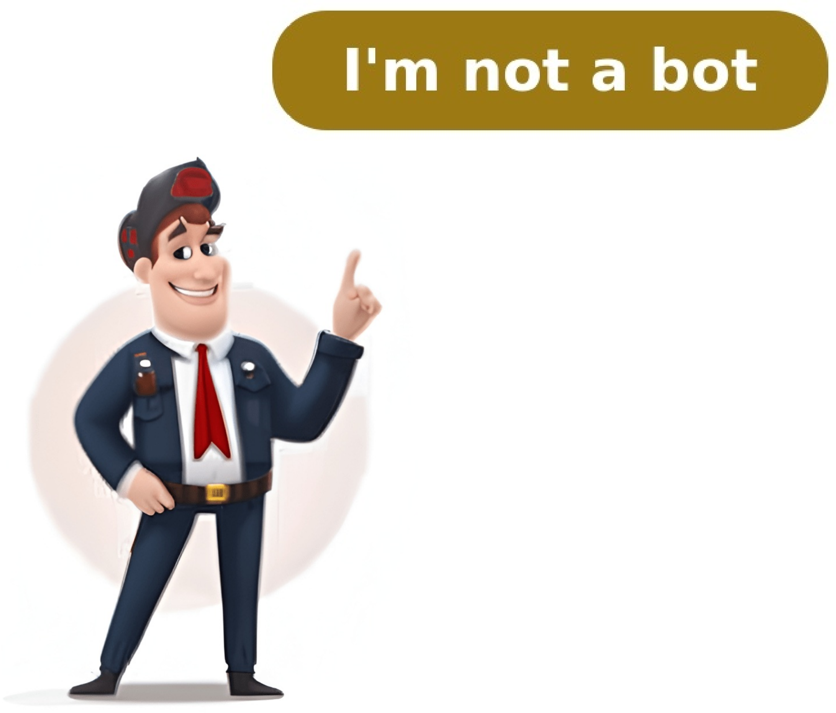
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The Geologic Time Scale or Geological Time Scale (GTS) is a chronological framework that organizes Earth's history into various units based on geological and paleontological evidence. It divides Earth's 4.6 billion-year history into hierarchical units such as eons, eras, periods, epochs, and ages. These divisions help scientists describe and interpret Earth's past, including the evolution of life, climatic changes, and tectonic events.Definition: The Geological Time Scale (GTS) organizes Earth's 4.6 billion-year history into hierarchical units (eons, eras, periods, epochs, and ages) based on geological and fossil records.Principles: The GTS relies on stratigraphic principles like the law of superposition, principle of faunal succession, and cross-cutting relationships to determine the relative ages of rock layers.Dating Methods: Combines relative dating (rock and fossil relationships) with absolute dating (radiometric techniques) for accurate chronological placement.Chronostratigraphy vs. Geochronology: Chronostratigraphy refers to the rock layers, while geochronology refers to the corresponding time intervals.Hierarchy: The GTS is divided into eons (largest), eras, periods, epochs, ages, and chrons (smallest).Fossil Correlation: Index fossils like trilobites and ammonites are essential for correlating rock layers globally.Dynamic Nature: The GTS evolves as new discoveries and improved dating techniques refine its accuracy.Significant Events: Key events like mass extinctions, the Cambrian Explosion, and Ice Ages mark boundaries within the GTS.Global Standard: Managed by the International Commission on Stratigraphy (ICS), the GTS ensures consistency in geological studies worldwide.Applications: Essential for understanding Earth's history, resource exploration, evolutionary biology, and climate change.Chronological dating combines relative and absolute dating techniques for estimating the age of geological formations and fossils. The GTS serves as a universal standard for understanding Earth's history and is essential for:Correlating rocks and fossils across different regions.Reconstructing past environments and climates.Studying the evolution of life through time.Identifying natural resources like fossil fuels and minerals.Units of the GTS are defined by the International Commission on Stratigraphy (ICS), a branch of the International Union of Geological Sciences (IUGS). These units are based on:Stratigraphy: The study of rock layers (strata) and their relationships.Global Boundary Stratotype Section and Point (GSSP): “Golden spikes” that mark the boundaries between geological time units.Radiometric Dating: Absolute dating using isotopes to determine precise ages.The GTS integrates both relative and absolute dating methods, relying on fossils, rock sequences, and isotopic data.The geologic time scale comes from several principles derived from stratigraphy and geology:Younger sedimentary layers deposit on top of older ones.Critical for determining the relative ages of strata.Sediments initially deposit in horizontal or nearly horizontal layers.Deviations indicate post-depositional processes like folding or faulting.Rock layers extend laterally until they thin out or encounter a barrier.Helps correlate rock layers over distances.A geologic feature (e.g., fault or intrusion) that cuts across layers is younger than the layers it disrupts.Rock fragments (inclusions) within a layer are older than the layer containing them.Fossil assemblages follow a predictable order in the rock record.Basis for biostratigraphy, allowing relative dating of layers.Gaps in the rock record caused by erosion or non-deposition.Types include disconformities, angular unconformities, and nonconformities.The present is the key to the past: geological processes operating today are similar to those in the past.These represent the physical rock layers corresponding to a time interval:Eonothem: Rocks formed during an eon.Erathem: Rocks formed during an era.System: Rocks formed during a period.Series: Rocks formed during an epoch.Stage: Rocks formed during an age.These are the time intervals themselves:Eon: Largest unit, spanning hundreds of millions to billions of years.Era: Subdivision of an eon, lasting tens to hundreds of millions of years.Period: Subdivision of an era, marked by significant events.Epoch: Subdivision of a period, shorter intervals of tens of millions of years.Age: Subdivision of an epoch, lasting millions of years.Chron: Smallest unit, used for fine-scale divisions.The four eons are the Hadean, Archean, Proterozoic, and Phanerozoic. The Hadean era lasted around 600 million years and includes the formation of the Earth and Moon. The Archean era lasted around 1.5 billion years, encompassing the formation of the crust and the first stirrings of life. The Proterozoic era lasted just under 2 billion years and included the development of the oxygen-rich atmosphere and the rise of eukaryotes. The Phanerozoic era began about 540 million years ago and continues to the present. It is characterized by increasing diversity and evolution of living organisms.The division of eras, periods, and epochs depends on the reference. Here are the overall divisions, but many sources further subdivide them.EonEraPeriodDates (MYA)Significant EventsHadean——4,600–4,000Formation of Earth and Moon, heavy bombardment.Archean——4,000–2,500Formation of Earth's crust, first life (prokaryotes).Proterozoic——2,500–541Oxygenation of the atmosphere, first eukaryotes.PhanerozoicPaleozoicCambrian541–485Cambrian Explosion of life.Ordovician485–444First land plants, marine biodiversity.Silurian444–419First jawed fish, vascular plants.Devonian419–359Age of Fish, first amphibians.Carboniferous359–299Coal swamps, first reptiles.Permian299–252Pangaea forms, mass extinction.MesozoicTriassic252–201First dinosaurs, mammals.Jurassic201–145Age of Dinosaurs, first birds.Cretaceous145–66Flowering plants, mass extinction.CenozoicPaleogene66–23Mammals diversify.Neogene23–2.58First hominins.Quaternary2.58–PresentIce Ages, rise of humans.Period further divide into epochs. For example, here are the epoch of the current era, the Cenozoic:EpochPeriodDates (MYA)Significant EventsPaleocenePaleogene66–56Mammal diversification after the dinosaur extinction.EocenePaleogene56–34First modern mammals and birds.OligocenePaleogene34–23Cooling climate, grasslands expand.MioceneNeogene23–5.3Proliferation of grasslands, first apes.PlioceneNeogene5.3–2.58Australopithecines appear.PleistoceneQuaternary2.58–0.0117Ice Ages, first Homo sapiens.HoloceneQuaternary0.0117–PresentHuman civilizations develop.Certain fossil groups have proven invaluable for dating and correlating rock layers across different regions. These fossils, known as index fossils, meet specific criteria: they are widespread geographically, abundant, and existed for a relatively short geological time span. Here are some key fossil groups:Trilobites (Cambrian to Permian)These marine arthropods are iconic of the Paleozoic Era. Their rapid evolution and diverse forms make them excellent markers, especially in the Cambrian and Ordovician periods.Ammonites (Devonian to Cretaceous)These extinct marine mollusks are crucial for Mesozoic stratigraphy. Ammonites evolved rapidly and are particularly useful for dating Jurassic and Cretaceous rocks.Graptolites (Cambrian to Carboniferous)Colonial organisms preserved as carbonized impressions in shale, graptolites are key markers for the Ordovician and Silurian periods.Conodonts (Cambrian to Triassic)Tiny, tooth-like fossils from primitive vertebrates, conodonts are valuable for detailed dating of Paleozoic rocks.Foraminifera (Cambrian to Present)These microscopic marine organisms are useful in both Paleozoic and Cenozoic stratigraphy. Planktonic foraminifera are especially helpful for dating Cretaceous and Cenozoic rocks.Radiolarians (Cambrian to Present)Single-celled organisms with siliceous skeletons, radiolarians are critical for dating deep-sea sediments.Brachiopods (Cambrian to Recent)Although still extant, their Paleozoic diversity makes them excellent markers for that era.Dinosaurs (Triassic to Cretaceous)Dinosaur fossils, though not as precise as smaller organisms, help in dating terrestrial Mesozoic rocks.Mammals (Cenozoic)Fossils of mammals and their ancestors, such as rodents and large mammals, are crucial for dating Neogene and Quaternary rocks.Plant FossilsFossilized plants, including spores and pollen (palynology), are valuable for dating terrestrial rocks from the Devonian to the present.The geologic time scale traces back to the ancient Greeks, Islamic philosophers, and Chinese naturalists, who noted the relationship between rocks and time. Arthur Holmes formulated the first modern GTS in 1911. Early geologists like William Smith and Charles Lyell laid its foundations with principles like faunal succession and uniformitarianism.Despite being literally “set in stone”. the GTS is not static. New discoveries, improved dating techniques, and revised interpretations lead to updates. Proposed revisions include refining boundaries between units and better correlating global rock records.How accurate are the dates on the GTS?The GTS is highly accurate for major boundaries, thanks to radiometric dating and biostratigraphy. However, minor adjustments occur as new data emerge.Can the GTS change over time?Yes. The GTS evolves with new discoveries, refined dating techniques, and improved global correlations.What's the difference between relative and absolute dating?Relative dating places events in sequential order based on rock layers and fossils, while absolute dating uses isotopic decay to provide precise numerical ages.Why are there gaps in the rock record?Gaps, called unconformities, result from erosion or periods of non-deposition. These gaps represent missing time in the geological record.What is the Anthropocene?The Anthropocene is a proposed epoch marking significant human impact on Earth's geology and ecosystems. It is not yet officially part of the GTS.How do scientists correlate rock layers globally?Scientists use index fossils, radiometric dating, and unique rock signatures (e.g., volcanic ash layers) to match layers across regions.Why are epochs shorter than periods or eras?Epochs represent finer divisions of time within periods, reflecting more specific events or changes in Earth's history.Can fossils date rocks directly?Fossils provide relative ages, but isotopic dating of surrounding rocks is required for absolute ages.What happens if a boundary's date changes?If new evidence alters a boundary date, the GTS is revised accordingly by the ICS, ensuring it reflects the best available science.Are there geological time scales for other planets?Yes, planetary scientists develop time scales for celestial bodies like Mars and the Moon, based on surface features, cratering, and stratigraphy.Absolute Dating: Determining the numerical age of a rock or fossil using methods like radiometric dating.Anthropocene: A proposed epoch denoting significant human impact on Earth's geology.Biostratigraphy: The study of rock layers based on fossil content.Chron: The smallest unit of geological time, used for fine-scale divisions.Eon: The largest division of geological time, spanning hundreds of millions to billions of years.Epoch: A subdivision of a period, representing shorter intervals.Era: A major division of time within an eon.GSSP (Global Boundary Stratotype Section and Point): A physical reference point marking the boundary between geological units.Index Fossil: A fossil used to define and identify a geological time unit.Period: A division of time within an era, often marked by significant events like mass extinctions.Principle of Faunal Succession: The concept that fossil assemblages follow a predictable order through strata.Relative Dating: Establishing the sequence of geological events without assigning numerical ages.Stratigraphy: The study of rock layers and their formation.Unconformity: A gap in the geological record caused by erosion or non-deposition.Aubry, Marie-Pierre; Van Couvering, John A.; et al. 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ISBN 978-1-64116-075-9.Related Posts The Geological Time Scale (GTS) is a systematic framework that organizes Earth's history into distinct intervals based on geological and biological events. The geologic time scale is the “calendar” for events in earth history. It subdivides all time into named units of abstract time called—in descending order of duration—eons, eras, periods, epochs, and ages.Here is the Latest Version of the Geological Time Scale PDF, designed for easy download and reference. Whether you are a student, educator, or professional in the field, this resource will enhance your understanding of Earth's complex history.The Geologic Time Scale (GTS) is a comprehensive framework that organizes Earth's history into distinct intervals based on geological and biological events. It serves as a chronological timeline, enabling scientists to understand the age of rocks, fossils, and the evolution of life on Earth. The GTS is divided into several hierarchical levels, starting with the largest time intervals known as eons, which are further divided into eras, periods, epochs, and ages.Download The Geologic Time Scale GSA, Latest VersionWithin the Phanerozoic Eon, there are three eras: the Paleozoic Era (541 to 252 million years ago), marked by the development of marine and land life; the Mesozoic Era (252 to 66 million years ago), often called the Age of Reptiles; and the Cenozoic Era (66 million years ago to present), known as the Age of Mammals. Each era is further divided into periods, such as the Cambrian and Jurassic, which are characterized by significant geological and biological changes. Read more here. 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Viseense Vi-se-en-se Wenlock Wen-lock Wenlock Wen-lock Wenlock Wen-lock Wordian Wor-d-i-an Wordien Wor-dien Wordiense Wor-dien-se Wuchiapingian Wu-chi-apin-gi-an Wuchiapingien Wu-chia-pin-gien Wuchiapingiense Wu-chia-pin-gien-se Wuliuan Wu-li-uan Wuliuen Wu-liuen Wuliuense Wu-liu-en-se Ypresian Ypre-sian Yprésien Y-pré-sien Ypresiense Y-pre-sien-se Zanclean Zan-clean Zancléen Zan-cléen Zancliense Zan-clien-se Compiler: Bruno Granier Date: 2022/12/17 The International Chronostratigraphic Chart describes the geological time in which the history of the Earth is inscribed. It combines a numerical scale that uses as a unit a million years (chronometric scale) and a scale in relative time units (chronostratigraphic scale). ForewordThe International Chronostratigraphic Chart describes the geological time in which the history of the Earth is inscribed. It combines a numerical scale that uses as a unit a million years (chronometric scale) and a scale in relative time units (chronostratigraphic scale).The chronostratigraphic scale is established by convention and is based on the International Standardized System of stratigraphical units (e.g., "Jurassic", "Paleocene" or "Hildoceras bifrons ammonite zone"). This system, regulated by the International Commission on Stratigraphy (ICS), describes the relative divisions of geological time (eons, eras and their sub-divisions), establishes the limits of the units and calibrates them with the chronometric scale, attributing to them the corresponding absolute ages.The lower boundaries of all units (stages, series, systems and erathems) are currently in the process of being defined by means of sections and points, as Global Stratotype Section and Boundary Point (GSSP).The Archean and the Proterozoic, which by convention were chronometrically defined as absolute numerical ages (Global Standard Stratigraphic Age - GSSA), are involved in this process.Official GSSP are marked in the table with the Golden Spike symbol, which is also placed on the ground. You can find the original table and the details of the ratified GSSP (criteria to define each one of them, geographic and geological location, correlation, etc.) at ages (Ma) of the unit boundaries in the Phanerozoic and the Ediacaran are subject to revision and do not define units. This will be made only by the GSSP. Regarding the limits of the Phanerozoic units that do not yet have an agreed GSSP, or the ones without a precise numerical age, the table provides an approximate numerical age (~).Numerical ages of all systems, except Triassic, Cretaceous and Precambrian, come from Gradstein et al. (A Geologic Time Scale 2012).Numerical ages of the lower Pleistocene, Triassic and Cretaceous are original contributions of the respective subcommissions of the ICS-IUGS.Colour code is according to the Commission for the Geological Map of the Word (CCGM-IUGS). Second epoch of the Neogene Period This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "Pliocene" – news · newspapers · books · scholar · JSTOR (January 2019) (Learn how and when to remove this message) Pliocene5.333 ± 0.08 – 2.58 ± 0.04 Ma Pre€ € O S D C P T J K Pg N ↓ A map of Earth as it appeared 5 million years ago during the Pliocene Epoch, Zanclean AgeChronology−24 —–−22 —–−20 —–−18 —–−16 —–−14 —–−12 —–−10 —–−8 —–−6 —–−4 —–−2 —CenozoicPgNeogeneQOligoceneMiocenePlio.PleistoceneAquitanianBurdigalianLanghianSerravallianTortonianMessinianZancleanPiacenzian ←Messinian salinity crisis[1]←North American prairie expands[2]Subdivision of the Neogene according to the ICS, as of 2023.[3]Vertical axis scale: Millions of years agoEtymologyName formalityFormalUsage informationCelestial bodyEarthRegional usageGlobal (ICS)Time scale(s) usedICS Time ScaleDefinitionChronological unitEpochStratigraphic unitSeriesTime span formalityFormalLower boundary definitionBase of the Thvera magnetic event (C3n.4n), which is only 96 ka (5 precession cycles) younger than the GSSPLower boundary GSSPHeraclea Minoa section, Heraclea Minoa, Cattolica Eraclea, Sicily, Italy37°23′30″N 13°16′50″E / 37.3917°N 13.2806°E / 37.3917; 13.2806Lower GSSP ratified2000[4]Upper boundary definition Base of magnetic polarity chronozone C2r (Matuyama) Extinction of the Haptophytes Discoaster pentaradiatus and Discoaster surculus Upper boundary GSSPMonte San Nicola Section, Gela, Sicily, Italy37°08′49″N 14°12′13″E / 37.1469°N 14.2035°E / 37.1469; 14.2035Upper GSSP ratified2009 (as base of Quaternary and Pleistocene)[5] Part of a series onHuman historyand prehistory ↑ before Homo (Pliocene epoch) Prehistory Stone Age Lower Paleolithic HomoHomo erectus Middle Paleolithic Early Homo sapiens Upper Paleolithic Behavioral modernity EpipalaeolithicMesolithic Neolithic Cradle of civilization Protohistory Copper Age Bronze Age EuropeNear EastSouth AsiaEast Asia Bronze Age collapse Iron Age EuropeNear EastSouth AsiaSoutheast AsiaEast AsiaWest Africa Recorded history Ancient history Earliest recordsProtohistory Post-classical history Modern history EarlyContemporary ↓ Future (Holocene epoch)vte The Pliocene (/ˈplaɪ.əsiːn, ˈplaɪ.oʊ-/ PLY-ə-seen, PLY-oh-;[6][7] also Pleiocene)[8] is the epoch in the geologic time scale that extends from 5.33 to 2.58[9] million years ago (Ma). It is the second and most recent epoch of the Neogene Period in the Cenozoic Era. The Pliocene follows the Miocene Epoch and is followed by the Pleistocene Epoch. Prior to the 2009 revision of the geologic time scale, which placed the four most recent major glaciations entirely within the Pleistocene, the Pliocene also included the Gelasian Stage, which lasted from 2.59 to 1.81 Ma, and is now included in the Pleistocene.[10] As with other older geologic periods, the geological strata that define the start and end are well-identified but the exact dates of the start and end of the epoch are slightly uncertain. The boundaries defining the Pliocene are not set at an easily identified worldwide event but rather at regional boundaries between the warmer Miocene and the relatively cooler Pleistocene. The upper boundary was set at the start of the Pleistocene glaciations. Charles Lyell (later Sir Charles) gave the Pliocene its name in Principles of Geology (volume 3, 1833).[11] The word pliocene comes from the Greek words πλεῖον (pleion, "more") and καινός (kainos, "new" or "recent")[12] and means roughly "continuation of the recent", referring to the essentially modern marine mollusc fauna. Some schemes for subdivisions of the Pliocene In the official timescale of the ICS, the Pliocene is subdivided into two stages. From youngest to oldest they are: Piacenzian (3.60–2.58 Ma)[13] Zanclean (5.33–3.60 Ma)[4] The Piacenzian is sometimes referred to as the Late Pliocene, whereas the Zanclean is referred to as the Early Pliocene. In the system of North American Land Mammal Ages (NALMA) include Hemphillian (9–4.75 Ma),[14][15] and Blancan (4.75–1.6 Ma).[16] The Blancan extends forward into the Pleistocene. South American Land Mammal Ages (SALMA) include Montehermosan (6.8–4.0 Ma), Chapadmalalan (4.0–3.0 Ma) and Uquian (3.0–1.2 Ma).[17] In the Paratethys area (central Europe and parts of western Asia) the Pliocene contains the Dacian (roughly equal to the Zanclean) and Romanian (roughly equal to the Piacenzian and Gelasian together) stages. As usual in stratigraphy, there are many other regional and local subdivisions in use. In Britain, the Pliocene is divided into the following stages (old to young): Gedgravian, Waltonian, Pre-Ludhamian, Ludhamian, Thurnian, Bramertonian or Antian, Pre-Pastonian or Baventian, Pastonian and Beestonian. In the Netherlands the Pliocene is divided into these stages (old to young): Brunssumian C, Reuverian A, Reuverian B, Reuverian C, Praetiglian, Tiglian A, Tiglian B, Tiglian C1-4b, Tiglian C4c, Tiglian C5, Tiglian C6 and Eburonian. The exact correlations between these local stages and the International Commission on Stratigraphy (ICS) stages is not established.[18] Mid-Pliocene reconstructed annual sea surface temperature anomaly During the Pliocene epoch (5.3 to 2.6 million years ago (Ma)), the Earth's climate became cooler and drier, as well as more seasonal, marking a transition between the relatively warm Miocene to the cooler Pleistocene.[19] However, the beginning of the Pliocene was marked by an increase in global temperatures relative to the cooler Messinian. This increase was related to the 1.2 million year obliquity amplitude modulation cycle.[20] By 3.3–3.0 Ma, during the Mid-Piacenzian Warm Period (mPWP), global average temperature was 2–3 °C higher than today,[21] while carbon dioxide levels were the same as today (400 ppm).[22] Global sea level was about 25 m higher,[23] though its exact value is uncertain.[24][25] The northern hemisphere ice sheet was ephemeral before the onset of extensive glaciation over Greenland that occurred in the late Pliocene around 3 Ma.[26] The formation of an Arctic ice cap is signaled by an abrupt shift in oxygen isotope ratios and ice-rafted cobbles in the North Atlantic and North Pacific Ocean beds.[27] Mid-latitude glaciation was probably underway before the end of the epoch. The global cooling that occurred during the Pliocene may have accelerated on the disappearance of forests and the spread of grasslands and savannas.[28] During the Pliocene the earth climate system response shifted from a period of high frequency-low amplitude oscillation dominated by the 41,000-year period of Earth's obliquity to one of low-frequency, high-amplitude oscillation dominated by the 100,000-year period of the orbital eccentricity characteristic of the Pleistocene glacial-interglacial cycles.[29] During the late Pliocene and early Pleistocene, 3.6 to 2.6 Ma, the Arctic was much warmer than it is at the present day (with summer temperatures some 8 °C warmer than today). That is a key finding of research into a lake-sediment core obtained in Eastern Siberia, which is of exceptional importance because it has provided the longest continuous late Cenozoic land-based sedimentary record thus far.[30] During the late Zanclean, Italy remained relatively warm and humid.[31] Central Asia became more seasonal during the Pliocene, with colder, drier winters and wetter summers, which contributed to an increase in the abundance of C4 plants across the region.[32] In the Loess Plateau, δ13C values of occluded organic matter increased by 2.5% while those of pedogenic carbonate increased by 5% over the course of the Late Miocene and Pliocene, indicating increased aridification.[33] Further aridification of Central Asia was caused by the development of Northern Hemisphere glaciation during the Late Pliocene.[34] A sediment core from the northern South China Sea shows an increase in dust storm activity during the middle Pliocene.[35] The South Asian Summer Monsoon (SASM) increased in intensity after 2.95 Ma, likely because of enhanced cross-equatorial pressure caused by the reorganisation of the Indonesian Throughflow.[36] In the south-central Andes, an arid period occurred from 6.1 to 5.2 Ma, with another occurring from 3.6 to 3.3 Ma. These arid periods are coincident with global cold periods, during which the position of the Southern Hemisphere westerlies shifted northward and disrupted the South American Low Level Jet, which brings moisture to southeastern South America.[37] From around 3.8 Ma to about 3.3 Ma, North Africa experienced an extended humid period.[38] In northwestern Africa, tropical forests extended up to Cape Blanc during the Zanclean until around 3.5 Ma. During the Piacenzian, from about 3.5 to 2.6 Ma, the region was forested at irregular intervals and contained a significant Saharan palaeoriver until 3.35 Ma, when trade winds began to dominate over fluvial transport of pollen. Around 3.26 Ma, a strong aridification event that was followed by a return to more humid conditions, which was itself followed by another aridification around 2.7 Ma. From 2.6 to 2.4 Ma, vegetation zones began repeatedly shifting latitudinally in response to glacial-interglacial cycles.[39] The climate of eastern Africa was very similar to what it is today. Unexpectedly, the expansion of grasslands in eastern Africa during this epoch appears to have been decoupled from aridification and not caused by it, as evidenced by their asynchrony.[40] Southwestern Australia hosted heathlands, shrublands, and woodlands with a greater species diversity compared to today during the Middle and Late Pliocene. Three different aridification events occurred around 2.90, 2.59, and 2.56 Ma, and may have been linked to the onset of continental glaciation in the Arctic, suggesting that vegetation changes in Australia during the Pliocene behaved similarly to during the Late Pleistocene and were likely characterised by comparable cycles of aridity and humidity.[41] The equatorial Pacific Ocean sea surface temperature gradient was considerably lower than it is today. Mean sea surface temperatures in the east were substantially warmer than today but similar in the west. This condition has been described as a permanent El Niño state, or "El Padre".[42] Several mechanisms have been proposed for this pattern, including increased tropical cyclone activity.[43] The extent of the West Antarctic Ice Sheet oscillated at the 40 kyr period of Earth's obliquity. Ice sheet collapse occurred when the global average temperature was 3 °C warmer than today and carbon dioxide concentration was at 400 ppmv. This resulted in open waters in the Ross Sea.[44] Global sea-level fluctuation associated with ice-sheet collapse was probably up to 7 meters for the west Antarctic and 3 meters for the east Antarctic. Model simulations are consistent with reconstructed ice-sheet oscillations and suggest a progression from a smaller to a larger West Antarctic ice sheet in the last 5 million years. Intervals of ice sheet collapse were much more common in the early-mid Pliocene (5 Ma – 3 Ma), after three-million-year intervals with modern or glacial ice volume became longer and collapse occurs only at times when warmer global temperature coincide with strong austral summer insolation anomalies.[45] Examples of migrant species in the Americas after the formation of the Isthmus of Panama. Olive green silhouettes denote North American species with South American ancestors; blue silhouettes denote South American species of North American origin. Continents continued to drift, moving from positions possibly as far as 250 km from their present locations to positions only 70 km from their current locations. South America became linked to North America through the Isthmus of Panama during the Pliocene, making possible the Great American Interchange and bringing a nearly complete end to South America's distinctive native ungulate fauna,[46] though other South American lineages like its predatory mammals were already extinct by this point and others like xenarthrans continued to do well afterwards. The formation of the Isthmus had major consequences on global temperatures, since warm equatorial ocean currents were cut off and an Atlantic cooling cycle began, with cold Arctic and Antarctic waters decreasing temperatures in the now-separated Atlantic Ocean.[47] Africa's collision with Europe formed the Mediterranean Sea, cutting off the remnants of the Tethys Ocean. The border between the Miocene and the Pliocene is also the time of the Messinian salinity crisis.[48][49] During the Late Pliocene, the Himalayas became less active in their uplift, as evidenced by sedimentation changes in the Bengal Fan.[50] The land bridge between Alaska and Siberia (Beringia) was first flooded near the start of the Pliocene, allowing marine organisms to spread between the Arctic and Pacific Oceans. The bridge would continue to be periodically flooded and restored thereafter.[51] Pliocene marine formations are exposed in northeast Spain,[52] southern California,[53] New Zealand,[54] and Italy.[55] During the Pliocene parts of southern Norway and southern Sweden that had been near sea level rose. In Norway this rise elevated the Hardangervidda plateau to 1200 m in the Early Pliocene.[56] In Southern Sweden similar movements elevated the South Swedish highlands leading to a deflection of the ancient Eridanos river from its original path across south-central Sweden into a course south of Sweden.[57] The Pliocene is bookended by two significant events in the evolution of human ancestors. The first is the appearance of the hominin Australopithecus anamensis in the early Pliocene, around 4.2 million years ago.[58][59][60] The second is the appearance of Homo, the genus that includes modern humans and their closest extinct relatives, near the end of the Pliocene at 2.6 million years ago.[61] Key traits that evolved among hominins during the Pliocene include terrestrial bipedality and, by the end of the Pliocene, encephalized brains (brains with a large neocortex relative to body mass[62][a] and stone tool manufacture.[63] Improvements in dating methods and in the use of climate proxies have provided scientists with the means to test hypotheses of the evolution of human ancestors.[63][64] Early hypotheses of the evolution of human traits emphasized the selective pressures produced by particular habitats. For example, many scientists have long favored the savannah hypothesis. This proposes that the evolution of terrestrial bipedality and other traits was an adaptive response to Pliocene climate change that transformed forests into more open savannah. This was championed by Grafton Elliot Smith in his 1924 book, The Evolution of Man, as "the unknown world beyond the trees", and was further elaborated by Raymond Dart as the killer ape theory.[65] Other scientists, such as Sherwood L. Washburn, emphasized an intrinsic model of hominin evolution. According to this model, early evolutionary developments triggered later developments. The model placed little emphasis on the surrounding environment.[66] Anthropologists tended to focus on intrinsic models while geologists and vertebrate paleontologists tended to put greater emphasis on habitats.[67] Alternatives to the savanna hypothesis include the woodland/forest hypothesis, which emphasizes the evolution of hominins in closed habitats, or hypotheses emphasizing the influence of colder habitats at higher latitudes or the influence of seasonal variation. More recent research has emphasized the variability selection hypothesis, which proposes that variability in climate fostered development of hominin traits.[63] Improved climate proxies show that the Pliocene climate of east Africa was highly variable, suggesting that adaptability to varying conditions was more important in driving hominin evolution than the steady pressure of a particular habitat.[62] This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (August 2017) (Learn how and when to remove this message) The change to a cooler, drier, more seasonal climate had considerable impacts on Pliocene vegetation, reducing tropical species worldwide. Deciduous forests proliferated, coniferous forests and tundra covered much of the north, and grasslands spread on all continents (except Antarctica). Eastern Africa in particular saw a huge expansion of C4 grasslands.[68] Tropical forests were limited to a tight band around the equator, and in addition to dry savannahs, deserts appeared in Asia and Africa.[69][failed verification] This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (August 2017) (Learn how and when to remove this message) Both marine and continental faunas were essentially modern, although continental faunas were a bit more primitive than today. The land mass collisions meant great migration and mixing of previously isolated species, such as in the Great American Interchange. Herbivores got bigger, as did specialized predators. The gastropod Oliva sayana, from the Pliocene of Florida The coral Cladocora from the Pliocene of Cyprus A gastropod and attached serpulid wormtube from the Pliocene of Cyprus The gastropod Turritella carinata from the Pliocene of Cyprus The thorny oyster Spondylus right and left valve interiors from the Pliocene of Cyprus The limpet Diodora italica from the Pliocene of Cyprus The scaphopod Dentalium from the Pliocene of Cyprus The gastropod Aporrhais from the Pliocene of Cyprus The arcid bivalve Anadara from the Pliocene of Cyprus The pectenid bivalve Ammusium cristatum from the Pliocene of Cyprus Vermetid gastropod Petaloconchus intortus attached to a branch of the coral Cladocora from the Pliocene of Cyprus Chesapecten, barnacles and sponge borings (Entobia) from the Pliocene of York River, Virginia Hominin timelineThis box: viewtalkedit−10 —–−9 —–−8 —–−7 —–−6 —–−5 —–−4 —–−3 —–−2 —–−1 —–0 — MiocenePliocenePleistoceneHomininiNakalipithecusSamburupithecusOuranopithecus(Ou. turkae)(Ou. macedoniensis)ChororapithecusOreopithecusSivapithecusSahelanthropusGraecopithecusOrrorin(O. praegens)(O. tugenensis)Ardipithecus(Ar. kadabba)(Ar. ramidus)Australopithecus(Au. africanus)(Au. afarensis)(Au. anamensis)H. habilis(H. rudolfensis)(Au. garhi)H. erectus(H. antecessor)(H. ergaster)(Au. sediba)H. heidelbergensisHomo sapiensNeanderthalsDenisovans ←Earlier apes←Gorilla split←Chimpanzee split←Earliest bipedal←Earliest sign of Ardipithecus←Earliest sign of Australopithecus←Earliest stone tools←Earliest sign of Homo←Dispersal beyond Africa←Earliest fire / cooking←Earliest rock art←Earliest clothes←Modern humansH o m i n i d sP a r a n t h r o p u s(million years ago) Nineteenth-century artist's impression of a Pliocene landscape In North America, rodents, large mastodons and gomphotheres, and opossums continued successfully, while hoofed animals (ungulates) declined, with camel, deer, and horse all seeing populations recede. Three-toed horses (Nannippus), oreodonts, protoceratids, and chalicotheres became extinct. Borophagine dogs and Agriotherium became extinct, but other carnivores including the weasel family diversified, and dogs and short-faced bears did well. Ground sloths, huge glyptodonts, and armadillos came north with the formation of the Isthmus of Panama. The latitudinal diversity gradient among terrestrial North American mammals became established during this epoch some time after 4 Ma.[70] In Eurasia rodents did well, while primate distribution declined. Elephants, gomphotheres and stegodonts were successful in Asia (the largest land mammals of the Pliocene were such proboscideans as Deinotherium, Anancus, and Mammut borsoni,[71]) though proboscidean diversity declined significantly during the Late Pliocene.[72] Hyraxes migrated north from Africa. Horse diversity declined, while tapirs and rhinos did fairly well. Bovines and antelopes were successful; some camel species crossed into Asia from North America. Hyenas and early saber-toothed cats appeared, joining other predators including dogs, bears, and weasels. Human evolution during the Pliocene Africa was dominated by hoofed animals, and primates continued their evolution, with australopithecines (some of the first hominins) and baboon-like monkeys such as the Dinopithecus appearing in the late Pliocene. Rodents were successful, and elephant populations increased. Cows and antelopes continued diversification and overtook pigs in numbers of species. Early giraffes appeared. Horses and modern rhinos came onto the scene. Bears, dogs and weasels (originally from North America) joined cats, hyenas and civets as the African predators, forcing hyenas to adapt as specialized scavengers. Most mustelids in Africa declined as a result of increased competition from the new predators, although Enhydriodon omoensis remained an unusually successful terrestrial predator. South America was invaded by North American species for the first time since the Cretaceous, with North American rodents and primates mixing with southern forms. Litopterns and the notoungulates, South American natives, were mostly wiped out, except for the macrauchenids and toxodonts, which managed to survive. Small weasel-like carnivorous mustelids, coatis and short-faced bears migrated from the north. Grazing glyptodonts, browsing giant ground sloths and smaller caviomorph rodents, pampatheres, and armadillos did the opposite, migrating to the north and thriving there. The marsupials remained the dominant Australian mammals, with herbivore forms including wombats and kangaroos, and the huge Diprotodon. Carnivorous marsupials continued hunting in the Pliocene, including dasyurids, the dog-like thylacine and cat-like Thylacoleo. The first rodents arrived in Australia. The modern platypus, a monotreme, appeared. Titanis The predatory South American phorusrhacids were rare in this time; among the last was Titanis, a large phorusrhacid that migrated to North America and rivaled mammals as top predator. Other birds probably evolved at this time, some modern (such as the genera Cygnus, Bubo, Struthio and Corvus), some now extinct. Alligators and crocodiles died out in Europe as the climate cooled. Venomous snake genera continued to increase as more rodents and birds evolved. Rattlesnakes first appeared in the Pliocene. The modern species Alligator mississippiensis, having evolved in the Miocene, continued into the Pliocene, except with a more northern range; specimens have been found in very late Miocene deposits of Tennessee. Giant tortoises still thrived in North America, with genera like Hesperotestudo. Madtsoid snakes were still present in Australia. The amphibian order Allocaudata became extinct. In the Western Atlantic, assemblages of bivalves exhibited remarkable stasis with regards to their basal metabolic rates throughout the various climatic changes of the Pliocene.[73] The Pliocene was a high water mark for species diversity among Caribbean corals. From 5 to 2 Ma, coral species origination rates were relatively high in the Caribbean, although a noticeable extinction event and drop in diversity occurred at the end of this interval.[74] This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "Pliocene" – news · newspapers · books · scholar · JSTOR (May 2021) (Learn how and when to remove this message) Oceans continued to be relatively warm during the Pliocene, though they continued cooling. The Arctic ice cap formed, drying the climate and increasing cool shallow currents in the North Atlantic. Deep cold currents flowed from the Antarctic. The formation of the Isthmus of Panama about 3.5 million years ago[75] cut off the final remnant of what was once essentially a circum-equatorial current that had existed since the Cretaceous and the early Cenozoic. This may have contributed to further cooling of the oceans worldwide. The Pliocene seas were alive with sea cows, seals, sea lions, sharks and whales. List of fossil sites (with link directory) ^ Because of the 2009 reassignment of the Pliocene-Pleistocene boundary from 1.8 to 2.6 million years ago, older papers on Pliocene hominin evolution sometimes include events that would now be regarded as taking place in the early Pleistocene.

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Stellar blasts may have killed ancient marine life" Science News Online retrieved February 2, 2002 UCMP Berkeley Pliocene Epoch Page Pliocene Microfossils: 100+ images of Pliocene Foraminifera Human Timeline (Interactive) – Smithsonian, National Museum of Natural History (August 2016). Howe, John Allan (1911). "Pliocene" . Encyclopædia Britannica. Vol. 21 (11th ed.). pp. 846–848. Retrieved from " The International Commission on Stratigraphy is the largest and oldest constituent scientific body in the International Union of Geological Sciences (IUGS). Its primary objective is to precisely define global units (systems, series, and stages) of the International Chronostratigraphic Chart that, in turn, are the basis for the units (periods, epochs, and age) of the International Geologic Time Scale; thus setting global standards for the fundamental scale for expressing the history of the Earth. 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