(U) Earth

UNCLASSIFIED

From Intellipedia

Earth ⊕ (often referred to as "The Earth") is the third planet in the solar system in terms of distance from the Sun, and the fifth in order of size. It is the largest of the planetary system's terrestrial planets and the only place in the universe currently known to support life. The Earth was formed around 4.57 billion (4.57×10^9)[1] years ago and its largest natural satellite, the Moon, was orbiting it shortly thereafter, around 4.533 billion years ago.

Contents

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Since it formed, the Earth has evolved through geologic and biological processes so that any traces of the original conditions have been virtually eliminated. The Crust is divided into several tectonic plates that gradually migrate across the surface over geologic time spans. The interior of the planet remains active, with a thick layer of partially molten mantle and an iron core that generates a magnetic field. The atmospheric conditions have been significantly altered by the presence of life forms, which create an ecological balance that modifies the surface conditions. About 70% of the surface is presently covered in salt water oceans, and the remainder consists of land surfaces in the form of continents and islands.

There is significant interaction between the Earth and the space environment. The Earth's relatively large Moon provides ocean tides and has gradually modified the length of the planet's rotation period. A cometary bombardment during the early history of the planet is believed to have formed the oceans. Later, asteroid impacts are understood to have caused significant changes to the surface environment. Changes in the orbit of the planet may also be responsible for the ice ages that have covered significant portions of the surface in glacial sheets.

CIA World Factbook – "The World" [redacted]

[redacted]

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Globally, the 20th century was marked by: (a) two devastating world wars; (b) the Great Depression of the

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1930s; (c) the end of vast colonial empires; (d) rapid advances in science and technology, from the first airplane flight at Kitty Hawk, North Carolina (US) to the landing on the moon; (e) the Cold War between the Western alliance and the Warsaw Pact nations; (f) a sharp rise in living standards in North America, Europe, and Japan; (g) increased concerns about the environment, including loss of forests, shortages of energy and water, the decline in biological diversity, and air pollution; (h) the onset of the AIDS epidemic; and (i) the ultimate emergence of the US as the only world superpower. The planet's population continues to explode (http://www.cia.ic.gov/references/cwfb/cfactbook/fields/2119.html#xx): from 1 billion in 1820, to 2 billion in 1930, 3 billion in 1960, 4 billion in 1974, 5 billion in 1987, 6 billion in 1999, and 7 billion in 2012. For the 21st century, the continued exponential growth in science and technology raises both hopes (e.g., advances in medicine) and fears (e.g., development of even more lethal weapons of war).

CIA World Factbook – The World/Population

7,021,836,029 (July 2012 est.) top ten most populous countries (in millions): China 1,343.24; India 1,205.07; United States 313.85; Indonesia 248.22; Brazil 205.72; Pakistan 190.29; Nigeria 170.12; Bangladesh 161.08; Russia 138.08; Japan 127.37

Lexicography

Terms that refer to the Earth can use the Latin root *terra-*, such as the word *terrestrial*. There is also the alternative Latin root *tellur-*, as used in words such as telluric, tellurian, tellurion and Tellurium. Both terms derive from the Roman goddess Terra, who was also called by the presumably more ancient name Tellūs Mater. Scientific terms such as geography, geocentric and geothermal use the Greek prefix *geo-*, derived from Terra Mater's Greek counterpart Gaia.

The English word "earth" has cognates in many modern and ancient languages. Examples in modern tongues include *aarde* in Dutch and *Erde* in German.

Symbol

The astronomical symbol for Earth consists of a circled cross, the arms of the cross representing a meridian and the equator. A variant puts the cross atop the circle.

History

Based on the available evidence, scientists have been able to reconstruct detailed information about the planet's past. Earth is believed to have formed around 4.55 billion years ago out of the solar nebula, along with the Sun and other planets. The proto-Earth formed as materials left over after the formation of the sun began to clump together in a process called Accretion, under the influence of gravity. As more and more mass was added, gravity-induced pressure, along with radioactive decay and energy imparted from continuing impact events, generated sufficient heat to melt the entire mass. Melting allowed material of different densities to organize themselves into layers, with the lowest density at the surface, and the high density at the core. As impacting and radioactivity declined, the outer layer of the planet cooled, resulting in the formation of solid crust. Outgassing and volcanic activity produced the primordial atmosphere; condensing water vapor, augmented by ice delivered by comets, produced the oceans.[2] The highly energetic chemistry is believed to have produced a self-replicating molecule around 4 billion years ago, and half a billion years later, the last universal common ancestor of all life lived.[3]

The development of photosynthesis allowed the sun's energy to be harvested directly and the resultant oxygen accumulated in the atmosphere and gave rise to the ozone layer.

The incorporation of smaller cells within larger ones resulted in the development of complex cells called eukaryotes.[4] Cells within colonies became increasingly specialized, resulting in true multicellular organisms. With the ozone layer absorbing harmful ultraviolet radiation, life colonized the surface of Earth.

Over hundreds of millions of years, continental plates in the crust formed and broke up as the surface of Earth continually reshaped itself. The continents have migrated across the surface of the Earth, occasionally combining to form a supercontinent. Roughly 750 million years ago, the earliest known supercontinent Rodinia, began to break apart. The continents later recombined to form Pannotia, 600-540 Mya, then finally Pangaea, which broke apart 180 mya.[5]

Since the 1960s it has been hypothesized that a severe glacial period between 750 and 580 million years ago, during the Neoproterozoic, covered much of the planet in a sheet of ice. This hypothesis has been termed the "Snowball Earth," and it is of particular interest as it precedes the Cambrian explosion when multi-cellular lifeforms began to proliferate.[6]

Since the Cambrian explosion, about 535 million years ago, there have been 5 distinct mass extinction events.[7] The last one occurred 65 million years ago, when a meteorite collision probably triggered the extinction of the (non-avian) dinosaurs and other large reptiles, but may have spared small animals such as mammals, which then resembled shrews. Over the last 65 million years, mammalian life diversified, and it is hypothesized that proto-humans appeared about 2 million years ago. As brain size increased, these hominids developed the use of tools and language. Later development of agriculture, and then civilization has allowed humans to affect the Earth in a short timespan like no other life form has before, affecting both the nature and quantity of other life forms as well as global climate.

(U) The Younger-Dryas Impact Hypothesis, 11,000 BCE (13,000 BP)

(U) A controversial theory in geology postulates that around 13,000 years ago (BP, *Before Present*) -- roughly 11,000 BCE -- there was a moment of "coherent catastrophism" in Earth's history, when broken pieces of the Taurid comet that had been drifting in the Sun's orbit collided with the passage of Earth. This is known as the **Younger-Dryas impact hypothesis**. The impact between our planet and the space debris, if it indeed took place, would explain a series of abrupt changes dated to that time. The Earth's temperature cooled dramatically for the next 1,000 years, many species of animals seemed to go simultaneously extinct, and there was a sudden shift in human culture in North America with the disappearance of the Clovis peoples: "It would have been the worst day ever in human history since the end of the ice age", says one scientist looking for proof of the event.

- (U) The Younger Dryas Impact Hypothesis proposes that the onset of the Younger Dryas climate reversal, Pleistocene megafaunal extinctions and disappearance of the Clovis paleoindian lithic technology were coeval and caused by continent-wide catastrophic effects of impact/bolide events in North America.
- (U) **While there are no known impact structures dated to the Younger Dryas onset**, physical evidence of the impact/bolide events is *argued* to be present in sediments spanning several continents at stratigraphic levels inferred to date to the Bolling-Aollerod/Younger Dryas boundary (YDB). Reports of nanometer to submicron-sized diamonds in YDB sediments, in particular the rare 2H hexagonal polytype of diamond, lonsdaleite, have been presented as strong evidence for shock processing of crustal materials.

(U) In contrast to the gradual warming of Earth's climate over the past 25,000 years or so, a long (1,200-year)

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period of climate cooling known as the **Younger Dryas** occurred roughly 12,000 years ago. Precisely what brought on this geological period, during which over 35 genera of North American Pleistocene megafauna became extinct, and when it began, has not been fully understood. New evidence in the form of platinum at dig sites across the United States provides a clue to the onset of the Younger Dryas. A team of researchers from the University of South Carolina recently (2015-16) discovered extensive, though microscopic, quantities of platinum, an element that is relatively rare on Earth but abundant in asteroids. The platinum anomaly, as the investigators call it, occurs at depths ranging from 55 centimeters to as much as 10 meters at the 11 widely separated sites they studied. The depths vary due to local geological and environmental conditions, but generally point to deposition around 12,800 years ago. In 2013, other scientists had found platinum in a Greenland ice core, at a depth that signified deposition 12,800 years ago and led to the Younger Dryas Impact Hypothesis: that a cosmic impact event caused the onset of the cooling period, the extinction of megafauna, a peak in biomass burning, and the end of Clovis culture, a prehistoric Paleoindian culture marked by distinctive stone tools. The new research confirms that there was a sizable impact or airburst at that time. The South Carolina team have ruled out volcanic eruptions and other events as possible sources of the platinum.[8]

- (U) The circa 13,000 BP "Younger-Dryas" Impact hypothesis is similar to another theory which postulates that a major meteorite struck the Earth around 65 million years ago, leading to the extinction of the dinosaurs.

(U) The Man Who Dated Earth: Clair C. Patterson

- (U) **Source Note**: The following (redacted) biography of Professor Patterson was written shortly after his death by a colleague and friend, George R. Tildon. It was published in June 1998 as a chapter in a collection of American scientific biographies for the National Academy of Sciences: Bographical Memoirs V.74 [redacted] *Biographic Memoirs Volume 74* contains the biographies of deceased members of the National Academy of Sciences and bibliographies of their published works. Each biographical essay was written by a member of the Academy familiar with the professional career of the deceased.

(U) Clair Cameron "Pat" Patterson (2 June 1922 - 5 December 1995) is best known for his determination of the age of the Earth. That was possible only after he had spent some five years establishing methods for the separation and isotopic analysis of lead at microgram and sub-microgram levels. His techniques opened a new field in lead isotope geochemistry for terrestrial as well as for planetary studies. Whereas terrestrial lead isotope data had been based entirely on galena ore samples, isotopes could finally be measured on ordinary igneous rocks and sediments, greatly expanding the utility of the technique. While subsequently applying the methodology to ocean sediments, he came to the conclusion that the input of lead into the oceans was much greater than the removal of lead to sediments, because human activities were polluting the environment with unprecedented, possibly dangerous, levels of lead.

(U) Patterson -- known to his friends as "Pat" -- graduated from Grinnell College, Iowa, with an A. B. degree in chemistry, and soon married. He and his wife then moved to the University of Iowa for graduate work, where Pat earned his an M. A. in 1944, with a thesis in molecular spectroscopy. After graduation in 1944, Pat was sent to Chicago to work on the Manhattan (atomic bomb) Project at the University of Chicago at the invitation of Professor George Glockler, for whom Pat had done his M. A. research. After several months there, he decided to enlist in the army, but the draft board rejected him because of his high security rating and sent him back to the University of Chicago. There it was decided that both Pat and his wife would go to Oak Ridge, Tennessee,

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to continue work on the Manhattan Project. At Oak Ridge, Patterson worked in the 235U electromagnetic separation plant and became acquainted with mass spectrometers. After the war it was natural for him to return to the University of Chicago to pursue his doctorate. After earning his PhD, he remained at Chicago and worked with Harrison Brown. Professor Brown had become interested in meteorites, and started a program to measure trace element abundances by the new analytical techniques that were developed during the war years. The meteorite data would serve to define elemental abundances in the solar system, which, among other applications, could be used to develop models for the formation of the elements. Patterson became involved in the project, measuring [the element] gallium in iron meteorites by neutron activation. Patterson measured the isotopic composition and concentration of small quantities of lead by developing new mass spectrometric techniques. In the early 1950s, Professor Brown accepted a faculty appointment at the California Institute of Technology (CalTech). Patterson accompanied him there and built facilities that set new standards for low-level lead work. **By 1953 he was finally able to carry out the definitive study, using the troilite (sulfide) phase of the Canyon Diablo iron meteorite to measure the isotopic composition of primordial lead, from which he determined an age for the Earth**. The chemical separation was done at CalTech, and the mass spectrometer measurements were still made at the University of Chicago in Mark Inghram's laboratory. The answer turned out to be 4.5 billion years, later refined to 4.55 billion years. The new age was substantially older than the commonly quoted age of 3.3 billion years, which was based on tenuous modeling of terrestrial lead evolution from galena deposits. He presented his findings in 1953 with the publication of his paper, **"The isotopic composition of meteoritic, basaltic and oceanic leads, and the age of the earth"**, submitted to the Subcommittee on Nuclear Processes in Geological Settings, published by National Academy of Sciences, Washington D.C.[9]

(U) Physical characteristics

When viewed from space, much of the Earth has a deep blue and white appearance, caused by the oceans and water clouds in the atmosphere. It has an albedo of 36.7%, which is exceeded only by Venus among the inner planets of the Solar System. Earth is the largest and densest of the inner planets.

Mass of the Earth = 5.9 X 10^{24kg}
Equatorial radius = 6,378.160km or 3,963.208mi

(U) Atmosphere

The atmospheric pressure on the surface of the Earth averages 101.3 Pascal, with a scale height of about 6km. At the surface it is approximately 78% nitrogen, 21% oxygen, with trace amounts of other gaseous molecules such as water vapor. The atmosphere is vital for Earth's life forms because it absorbs ultraviolet solar radiation and most cosmic rays, moderates temperature extremes, transports water vapor, and provides essential gases.

(U) Geology

The Earth's shape is that of an oblate spheroid, with an average diameter of approximately 12,742km.[10] The Earth consists of atmospheric, hydrologic, and geologic layers. The primary geologic layers are the Crust, the mantle, and core.

The geologic component layers of the Earth[11] are located at the following depths below surface:

Lithologic layers (based on kinds of rocks)

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Depth		
Kilometres	Miles	Layer
0–35	0–22	Crust (varies between 5 and 70 km)
35–2890	22–1790	Mantle
2890–5100	1790–3160	Outer core
5100–6378	3160–3954	Inner core

Physical layers (based on physical properties like density and seismic velocity)

Depth		
Kilometres	Miles	Layer
0–150	0–37	Lithosphere (~50 km beneath oceans; ~200 km beneath continents)
100–700	62–435	Asthenosphere
700–2890	435–1790	Mesosphere
2890–5100	1790–3160	Outer core
5100–6378	3160–3954	Inner core

Earth in the solar system

It takes the Earth, on average, 23 hours, 56 minutes and 4.091 seconds (1 sidereal day) to rotate around its axis of rotation. From the Earth's surface, the main apparent motion of celestial bodies is the movement to the west at a rate of 15 °/h = 15'/min, i.e., a Sun or Moon diameter every two minutes.

Earth orbits the Sun every 365.2564 mean solar days (1 sidereal year). From Earth, this gives an apparent movement of the Sun with respect to the background stars at a rate of about 1 °/day, i.e., a Sun or Moon diameter every 12 hours, eastward. The orbital speed of the Earth averages about 30 km/s (108,000 km/h), enough to cover one Earth diameter (~12,600 km) in 7 minutes.

Earth has one natural satellite, the Moon, which revolves with the Earth around a common barycenter, from fixed star to fixed star, every 27.32 days (sidereal lunar month). When combined with the Earth-Moon system's common revolution around the Sun, the period of the synodic month, from new moon to new moon, is 29.53 days.

Viewed from Earth's north pole, the motion of Earth, its Moon and their axial rotations are all counterclockwise. The orbital and axial planes are not aligned: the plane of Earth's axis is tilted some 23.5 degrees against the Earth-Sun plane a fact which which causes the seasons. The Earth-Moon plane is tilted about 5 degrees against the Earth-Sun plane (otherwise there would be an eclipse every month).

In an inertial reference frame, the Earth's axis undergoes a slow precessional motion with a period of some 25,800 years, as well as a nutation with a main period of 18.6 years. These motions are caused by the differential attraction of Sun and Moon on the Earth's equatorial bulge, due to its oblateness. In a reference frame attached to the solid body of the Earth, its rotation is also slightly irregular due to polar motion. The polar motion is quasi-periodic, containing an annual component and a component with a 14-month period called the Chandler wobble. Also, the rotational velocity varies, resulting in a length of day variation.

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In modern times, Earth's perihelion is always about January 3rd, and aphelion is about July 4th (near the solstices, which are about December 21st and June 21st).

Magnetic field

The Earth's Magnetic Field is shaped roughly as a magnetic dipole with the poles currently located proximate to the planet's geographic poles. The field forms the Magnetosphere that deflects particles in the Solar Wind. The bow shock is located approximately 13.5 R_E. The collision between the magnetic field and the solar wind forms the Van Allen radiation belts, a pair of concentric, torus-shaped regions of energetic charged particles. When the plasma enters the Earth's atmosphere at the magnetic poles, it forms Aurora.

(U) The Moon

(U) Moon (Supermoon of Nov 2016)

(U) The Moon, sometimes called 'Luna', is a relatively large terrestrial planet-like satellite, whose diameter is about one-quarter of the Earth's. The natural satellites orbiting other planets are called "moons", after Earth's Moon.

Name	Diameter (km)	Mass (kg)	Semi-major axis (km)	Orbital period
Moon	3,474.8	7.349 x e^{22}	384,400	27 Days, 7 hours, 43.7 minutes

(U) The gravitational attraction between the Earth's oceans and Moon cause the tides on Earth. The same effect on the Moon has led to its becoming tidal locked: its rotation period is the same as the time it takes to orbit the Earth. As a result, it always presents the same face to the planet. As the Moon orbits Earth, different parts of its face are illuminated by the Sun, leading to the lunar phases. The dark part of the face is separated from the light part by the (solar) terminator. Due to this tidal locking, from any point on the Moon's surface, the Earth does not rise or set, but is always located in the same position in the sky.

(U) These same tidal interactions cause the Earth-Moon system to lose rotational energy. As a result the Moon recedes from Earth at the rate of approximately 38mm per year. The Earth rotation slows which lengthens its day by about 17 Microsecond every year. Over millions of years these tiny modifications have added up to significant changes, for example, during the Devonian period there were 400 days in a year, with each day lasting 21.8 hours.

(U) The Moon may dramatically affect the development of life by taming the weather. Paleontological evidence and computer simulations show that Earth's axial tilt is stabilized by tidal interactions with the Moon.[12] Some theorists believe that, without this stabilization against the torques applied by the Sun and planets to the Earth's equatorial bulge, the rotational axis might be chaotically unstable, as it appears to be with Mars. If Earth's axis of rotation were to approach the plane of the ecliptic, extremely severe weather could result, as this would make seasonal differences extreme. One pole would be pointed directly toward the Sun during *summer* and directly away during *winter*.

(U) The Moon is currently just far enough away to have, when seen from Earth, very nearly the same apparent angular size as the Sun (the Sun is 400 times larger, but the Moon is 400 times closer). This allows total and annular eclipses to occur on Earth. Since the plane of the Moon's orbit is tipped by five degrees relative to the plane of the Earth's orbit, the shadow of the Earth does not usually fall on the Moon. This is why we don't have a lunar eclipse most months.[13]

(U) The most widely accepted theory of the Moon's origin, the Giant impact theory, states that it was formed after the collision of a Mars-sized protoplanet with the early Earth. This hypothesis explains (among other things) the Moon's relative lack of iron and volatile elements, and the fact that its composition is nearly identical to that of the Earth's crust.

(U) Earth also has at least two co-orbital satellites: the asteroids named 3753 Cruithne and 2002 AA_{29}.

(U) Ownership of the Moon Prohibited by U.N. Treaty

(U) When Neil Armstrong planted an American flag on the moon (21 July 1969, Apollo 11), the United States was not actually staking a claim on the celestial orb. And, thanks to the United Nations 1967 Outer Space Treaty, no nation can. On 27 January 1967, the Outer Space Treaty, already adopted by the U.N.'s General Assembly, opened for signature. In the midst of the Cold War, the treaty provided a hopeful moment of international agreement-- especially because the U.S. and the Soviet Union/Russia were among the more than 60 countries to sign it on that first day. The treaty declared that the moon and other "celestial bodies" were "the province of all mankind" and can only be used for peaceful purposes. The treaty also keeps weapons of mass destruction out of orbit, bans military activity in space and asks that states inform the public and scientific community "of the nature, conduct, locations and results" of any outer space activities.[14]

(U) The 1967 treaty strictly prohibits claims by sovereign nations, but it does not expressly prohibit private entities from claiming private property rights. The treaty says nothing about those non-governmental actors claiming property rights, however. "It doesn't prohibit them, it doesn't allow them. It's completely silent," said Joanne Gabrynowicz, a professor emerita of space law at the University of Mississippi (speaking in February 2014) who acts as an official observer to the UN effort to oversee the legal framework governing use of space.[15]

- (U) See Outer Space Treaty of 1967

(U) **1984 Moon Agreement**: The United Nations Office for Outer Space Affairs hosts the Moon Agreement, which states that the moon's environment should not be disrupted, that it should be used only for peaceful purposes, "that the moon and its natural resources are the common heritage of mankind" and that "an international regime" should be established "to govern the exploitation of the natural resources of the moon when such exploitation is about to become feasible". The problem is that the seven nations which have ratified the Moon Agreement have no investment in it -- they are not space-faring. The US, China and Russia are not a party to the agreement.

(U) **U.S. to License Firms to Mine the Moon**: The Federal Aviation Administration, in a late-December 2014 letter to Bigelow Aerospace, said the agency intends to 'leverage the FAA's existing launch licensing authority to encourage private sector investments in space systems by ensuring that commercial activities can be conducted on a non-interference basis.' The FAA's letter noted a concern flagged by the U.S. State Department that 'the national regulatory framework, in its present form, is ill-equipped to enable the U.S. government to fulfill its obligations' under a 1967 United Nations treaty, which, in part, governs activities on the moon.[16]

(U) **Mining on the Moon**: A feature article in the January 2017 issue of *Mining Engineering* magazine stated--

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Outer space technology and exploration have reached a tipping point, so that mining and mineral processing in outer space is now a certainty and not a dream. Several competing companies worldwide are on the way to building spaceships to land on the Moon and eventually mine the Moon and asteroids for volatiles (useful for processing and habitation), rare earth metals, titanium and Helium-3. Almost nonexistent on earth, Helium-3 is accessible on the Moon and can be used in nuclear fusion power plants, producing much more energy than fission reactions and with much less radioactive waste. One of the main reasons Helium-3 is sought after as a fusion fuel is because there are no neutrons generated as a reaction product. Governments and private companies project mining for Helium-3 on the Moon in their future economic models.[17]

(U) **Water Detected on the Moon**:The Indian Space Research Organization's (ISRO) Chandrayaan Moon Mineralogy Mapper (M^3) imaging spectrometer detected water on the Moon. M^3 detected absorption features near ~-5.8 μm (-7.9×10^{-6} in) on the surface of the Moon. For silicate bodies, such features are typically attributed to hydroxyl and/or water-bearing materials. On the Moon, the feature appears strongest at cooler high latitudes and some feldspathic craters. OH/H_2O production processes may feed the polar regolith. The Chandrayaan mission data also registered a wide array of watery signals, with an estimate that the Lunar regolith contains ~ 0.1% water by weight.[18]

(U) NASA announced on November 13, 2009 that the LCROSS mission had also detected quantities of water ice on the Moon around the LCROSS impact site at Cabeus (crater). "The 30 m crater ejected by the probe contained 10 million kilograms of regolith and within this ejecta, an estimated 100 kg of water was detected. That represents a proportion of ten parts per million, which is a very low water concentration. Although the Moon is very dry on the whole, the spot where the LCROSS impactor hit was chosen for a high concentration of water ice. Researchers estimated that the regolith at the impact site contained 5.6 ± 2.9% water ice, and also noted the presence of other volatile substances. Hydrocarbons, material containing sulfur, carbon dioxide, carbon monoxide, methane and ammonia were present.[19]

(U) In March 2010, NASA reported that the findings of its mini-SAR radar aboard Chandrayaan-1 were consistent with ice deposits at the Moon's north pole. It is estimated there is at least 600 million tons of ice at the north pole in sheets of relatively pure ice at least a couple of meters thick.[20] In March 2014, researchers who had previously published reports on possible abundance of water on the Moon, reported new findings that refined their predictions substantially lower.[21]

(U) Maps of the Moon by Johannes Hevelius

(U) Moon Topography Names (Principal Maria and Craters)

(U) Johannes Hevelius (1611-87), under the tutelage of the astronomer Peter Krüger, in 1641 he built an observatory, called *Sternenburg* ("Star Castle"). He ground his own lenses and built telescopes for it, including one 46 meters (150 feet) - long Keplerian telescope with a wood and wire tube. He published *Selenographia* (1647), the first selenographical Atlas -- a work dedicated entirely to the moon -- with 111 plates and engravings, which he had drawn and engraved himself. These engravings showed the moon in every phase and included one composite map of all the features of the moon's surface. This became the model for all later lunar maps. His lunar maps were the most accurate surveys of the moon at that time. Today he is remembered as the founder of lunar topography. A large crater on the edge of the Ocean of Storms bears his name.

CIA World Factbook – The World/Geography

Main article: Geography

The surface of the earth is approximately 70.9% water and 29.1% land. The former portion is divided into large water bodies termed oceans. The World Factbook recognizes and describes five oceans, which are in decreasing order of size: the Pacific Ocean, Atlantic Ocean, Indian Ocean, Southern Ocean, and Arctic Ocean. The land portion is generally divided into several, large, discrete landmasses termed continents. Depending on the convention used, the number of continents can vary from five to seven. The most common classification recognizes seven, which are (from largest to smallest): Asia, Africa, North America, South America, Antarctica, Europe, and Australia. Asia and Europe are sometimes lumped together into a Eurasian continent resulting in six continents. Alternatively, North and South America are sometimes grouped as simply the Americas, resulting in a continent total of six (or five, if the Eurasia designation is used). North America is commonly understood to include the island of Greenland, the isles of the Caribbean, and to extend south all the way to the Isthmus of Panama. The easternmost extent of Europe is generally defined as being the Ural Mountains and the Ural River; on the southeast the Caspian Sea; and on the south the Caucasus Mountains, the Black Sea, and the Mediterranean. Portions of Azerbaijan, Georgia, Kazakhstan, Russia, and Turkey fall within both Europe and Asia, but in every instance the larger section is in Asia. These countries are considered part of both continents. Armenia and Cyprus, which lie completely in Western Asia, are geopolitically European countries. Asia usually incorporates all the islands of the Philippines, Malaysia, and Indonesia. The islands of the Pacific are often lumped with Australia into a "land mass" termed Oceania or Australasia. Africa's northeast extremity is frequently delimited at the Isthmus of Suez, but for geopolitical purposes, the Egyptian Sinai Peninsula is often included as part of Africa. Although the above groupings are the most common, different continental dispositions are recognized or taught in certain parts of the world, with some arrangements more heavily based on cultural spheres rather than physical geographic considerations.

Map references:

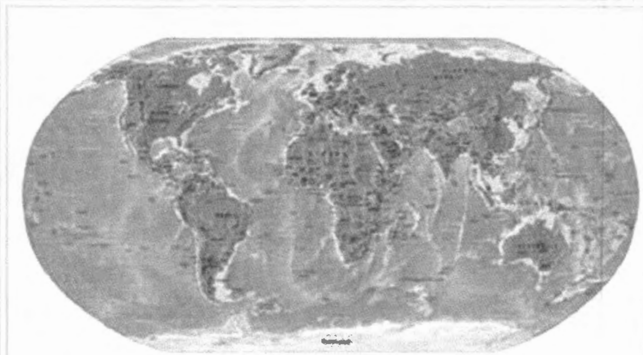
Time Zones, Coordinates.

Biggest geographic subdivision

Continents, Oceans

Area:

- *Total:* 510.072 million. km^2
- *Land:* 148.940 million km^2
- *Water:* 361.132 million km^2
- *Note:* 70.8 % of the world's surface is covered by water, 29.2 % is exposed land



Physical map of the Earth (Medium) (Large 2 MB)

Total water: 1.4×10^9 km^3, of which 2.5% is freshwater.[22]

Land boundaries: the land boundaries in the world total 250,472 km[23] (not counting shared boundaries twice)

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Coastline: 356,000 km.[23] (other figures vary substantially depending on how precisely it is measured, tides etc)

Maritime claims: see United Nations Convention on the Law of the Sea

- *Contiguous zone:* 24 nautical miles (44 km) claimed by most, but can vary
- *Continental shelf:* 200 m depth claimed by most or to depth of exploitation; others claim 200 nautical miles (370 km) or to the edge of the continental margin
- *Exclusive fishing zone:* 200 nautical miles (370 km) claimed by most, but can vary
- *Exclusive economic zone:* 200 nautical miles (370 km) claimed by most, but can vary
- *Territorial sea:* 12 nautical miles (22 km) claimed by most, but can vary
- *Note:* boundary situations with neighboring states prevent many countries from extending their fishing or economic zones to a full 200 nautical miles (370 km)
- 42 nations and other areas are completely landlocked (see list of landlocked countries)

Plate tectonics

Plate tectonics (from the Greek word for "one who constructs and destroys", τεκτων, *tektoon*) is a theory of geology which provides a physical mechanism for continental drift, an observation espoused by Alfred Wegener in the 1920s. Wegener noted the complementary shapes of continental coastlines, similar rock sequences in Africa and South America, common fossil species on disparate continents, and cold-climate fossils and sediments in tropical locations, and surmised that in the geologic past all continental landmasses were joined in a single super-continent, which he called *Pangaea*; the continents, according to Wegener, had "drifted" apart to their present positions. Unfortunately, Wegener's hypothesis stalled because he lacked an explanation for how the landmasses might move. In the early 1960s, Harry Hess, a Princeton University oceanography professor, suggested that the mid-ocean ridges are sites of creation of new oceanic crust, which then gets pushed away from the ridge to make way for the next batch of new crust. This idea, which is known as sea-floor spreading, was subsequently confirmed by Fred Vine and D.H. Matthews, who found patterns of magnetic orientation, a signature imparted to the rock by the Earth's magnetic field at the time the rocks formed, mirrored on either side of the mid-Atlantic ridge. In addition, geologists saw that earthquakes hypocenters in the vicinity of volcanic island arcs and continental margins were arranged along a plane dipping towards the Earth's interior at an angle of around 45 degrees, to depths of up to 680 km. These planes are known as *Wadati-Benioff zones*, and they define the upper surface of a slab of oceanic lithosphere that is sinking into the asthenosphere at a subduction zone. These ideas allowed scientists to realize that the Earth's surface is divided into 8 major *plates* and several smaller plates, which comprise both continental landmasses and oceanic lithosphere.

Plate tectonics is currently the theory accepted by the vast majority of scientists working in this area. In the theory of plate tectonics the outermost part of the **Earth**'s interior is made up of two layers: the lithosphere comprising the crust and the solidified uppermost part of the Earth's mantle. Below the lithosphere lies the asthenosphere which comprises the inner, viscous part of the mantle. The mantle behaves like a superheated and extremely viscous liquid.

The lithospheric plates essentially *float* on the asthenosphere. These plates move in relation to one another at one of three types of plate boundaries: convergent, divergent, and transform. Earthquakes, volcanic activity, mountain-building, and oceanic trench formation occur along plate boundaries.

Motion of the plates is driven by thermal convection within the mantle. Heat left over from the Earth's formation as well as heat generated by decay of radioactive elements distributed throughout the Earth causes some portions of the mantle to become less dense. These pockets of low-density rock ascend towards the surface, where they cool and descend back towards the core. Rolling convection cells form, carrying the overlying plates laterally.

Plate tectonic theory has revolutionized the Earth sciences, comparable in its unifying and explanatory power for diverse geological phenomena as was the development of the periodic table for chemistry, the discovery of the genetic code for biology, and quantum mechanics in physics.

Environment and ecosystem

The planet's lifeforms are sometimes said to form a "biosphere". This biosphere is generally believed to have begun evolving about 3.5 billion (3.5 x e^9) years ago. Earth is the only place in the universe where life is absolutely known to exist, and some scientists believe that biospheres might be rare.

The biosphere is divided into a number of biomes, inhabited by broadly similar flora and fauna. On land, biomes are separated primarily by latitude. Terrestrial biomes lying within the Arctic and Antarctic Circles are relatively barren of plant and animal life, while most of the more populous biomes lie near the Equator.

Climate

The most prominent features of the earth's climate are its two large polar regions, two narrow temperate zones, and a wide equatorial tropical to subtropical region. Precipitation patterns vary widely, ranging from several meters of water per year to less than a millimetre.

Ocean currents are important factors in determining climate, particularly the spectacular thermohaline circulation which distributes heat energy from the equatorial oceans to the polar regions.

Terrain

The Earth's terrain can vary greatly from place to place. The globe's surface is over 70% covered with water and much of the Earth's continental shelf is below sea level. If all of the land on Earth were spread evenly, then water would rise higher than the Statue of Liberty.[24] The remaining 30% that is dry land has mountains, deserts, plains, plateaus, etc.

Currently the total arable land is 13.31% of the land surface, with only 4.71% supporting permanent crops.[23] Close to 40% of the Earth's land surface is presently used for cropland and pasture, or an estimated 3.3×10^9 acres of cropland and 8.4×10^9 acres of pastureland pastureland.[25]

Extremes

Elevation extremes: (measured relative to sea level)

- Lowest point on land: Dead Sea −417 m
- Lowest point overall: Challenger Deep of the Mariana Trench in the Pacific Ocean −10,924 m [26]
- Highest point: Mount Everest 8,844 m (2005 est.)

Natural resources

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Main article: Natural resource

- Earth's crust contains large deposits of fossil fuels: (coal, petroleum, natural gas, methane clathrate). These deposits are used by humans both for energy production and as feedstock for chemical production.
- Mineral ore bodies have been formed in Earth's crust by the action of erosion and plate tectonics. These bodies form concentrated sources for many metals and other useful elements.
- Earth's biosphere produces many useful biological products, including (but far from limited to) food, wood, pharmaceuticals, oxygen, and the recycling of many organic wastes. The land-based ecosystem depends upon topsoil and fresh water, and the oceanic ecosystem depends upon dissolved nutrients washed down from the land.

Some of these resources, such as mineral fuels, are difficult to replenish on a short time scale, called non-renewable resources. The exploitation of non-renewable resources by human civilization has become a subject of significant controversy in modern environmentalism movements.

Land use

- *Arable land:* 13.13%[23]
- *Permanent crops:* 4.71%[23]
- *Permanent pastures:* 26%
- *Forests and woodland:* 32%
- *Urban areas:* 1.5%
- *Other:* 30% (1993 est.)

Irrigated land: 2,481,250 km^2 (1993 est.)

Natural and environmental hazards

Large areas are subject to extreme weather such as (tropical cyclones), hurricanes, or typhoons that dominate life in those areas. Many places are subject to earthquakes, landslides, tsunamis, volcanic eruptions, tornadoes, sinkholes, blizzards, floods, droughts, and other calamities and disasters.

Large areas are subject to human-made pollution of the air and water, acid rain and toxic substances, loss of vegetation (overgrazing, deforestation, desertification), loss of wildlife, species extinction, soil degradation, soil depletion, erosion, and introduction of invasive species.

Long-term climate alteration due to enhancement of the greenhouse effect by human industrial carbon dioxide emissions is an increasing concern, the focus of intense study and debate.

Human geography

Main article: Human geography

Earth has approximately 6,500,000,000 human inhabitants (February 24, 2006 estimate).[27] Projections indicate that the world's human population will reach seven billion in 2013 and 9.1 billion in 2050 (2005 UN estimates). Most of the growth is expected to take place in developing nations. Human population density varies widely around the world.

It is estimated that only one eighth of the surface of the Earth is suitable for humans to live on — ~70% is

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covered by oceans, and ~15% of the surface area is desert, high mountains or other unsuitable terrain.

The northernmost settlement in the world is Alert, Ellesmere Island, Canada. The southernmost is the Amundsen-Scott South Pole Station, in Antarctica, almost exactly at the South Pole.

Descriptions of Earth

Earth has often been personified as a deity, in particular a goddess (*see Gaia and Mother Earth*). The Chinese Earth goddess Hou-Tu is similar to Gaia, the deification of the Earth. As the patroness of fertility, her element is Earth. In Norse mythology, the Earth goddess Jord was the mother of Thor and the daughter of Annar. Ancient Egyptian mythology is different than that of other cultures because Earth is male, Geb, and sky is female, Nut.

Although commonly thought to be a sphere, the earth is actually an oblate spheroid. It bulges slightly at the equator and is slightly flattened at the poles. In the past there were varying levels of belief in a flat Earth, but ancient Greek philosophers and, in the Middle Ages, thinkers such as Thomas Aquinas believed that it was spherical.

Prior to the introduction of space flight, these inaccurate beliefs were countered with deductions based on observations of the secondary effects of the Earth's shape and parallels drawn with the shape of other planets. Cartography, the study and practice of mapmaking, and vicariously geography, have historically been the disciplines devoted to depicting the Earth. Surveying, the determination of locations and distances, and to a somewhat lesser extent navigation, the determination of position and direction, have developed alongside cartography and geography, providing and suitably quantifying the requisite information.

The technological developments of the latter half of the 20th century have altered the public's perception of the Earth. Before space flight, the popular image of Earth was of a green world. Science fiction artist Frank R. Paul provided perhaps the first image of a cloudless *blue* planet (with sharply defined land masses) on the back cover of the July 1940 issue of *Amazing Stories*, a common depiction for several decades thereafter.[28] Apollo 17's 1972 "Blue Marble" photograph of Earth from cislunar space became the current iconic image of the planet as a marble of cloud-swirled blue ocean broken by green-brown continents. A photo taken of a distant Earth by *Voyager 1* in 1990 inspired Carl Sagan to describe the planet as a "Pale Blue Dot".[29]

Earth's future

The most probable known cause for the Earth's destruction would be the Sun's expansion in its Red Giant stage of stellar evolution. Current models predict that the Sun will expand out to about 99% of the distance to the Earth's present orbit (1 Astronomical Unit, or AU). However by that time the orbit of the Earth will expand to about 1.7 AU due to mass loss by the Sun, and so the planet will escape envelopment.[30] This event is currently expected to take place in ~5 billion years. (5 Gyr).

Before reaching the Red Giant stage, however, the luminosity of the Sun will slowly increase. It will grow from the current luminosity by 10% in ~1.1 Gyr and up to 40% in ~3.5 Gyr.[30] Climate models show that a steady increase in radiation reaching the Earth will have dire consequences, including possible loss of the oceans.[31]

See also

See also: Geology

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References

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[redacted]

- NASA's Earth fact sheet (http://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html)
- *Discovering the Essential Universe* (Second Edition) by Neil F. Comins (2001)
- space.about.com – Earth – Pictures and Astronomy Facts (http://space.about.com/od/earth/a/earthinfo_2.htm)

Notes

1. G.B. Dalrymple, 1991, "The Age of the Earth", *Stanford University Press*, California, ISBN 0-8047-1569-6.
2. A. Morbidelli *et al*, 2000, "Source Regions and Time Scales for the Delivery of Water to Earth (http://adsabs.harvard.edu/abs/2000M&PS...35.1309M)", *Meteoritics & Planetary Science*, vol. 35, no. 6, pp. 1309–1320.
3. W. Ford Doolitte, "Uprooting the Tree of Life", *Scientific American*, Feb. 2000.
4. L. V. Berkner, L. C. Marshall, 1965, "On the Origin and Rise of Oxygen Concentration in the Earth's Atmosphere", *Journal of the Atmospheric Sciences*, Vol. 22, No. 3, pp. 225–261.
5. J.B. Murphy, R.D. Nance, "How do supercontinents assemble? (http://scienceweek.com/2004/sa040730-5.htm)", *American Scentist*, vol. 92, pp. 324–333.
6. J.L. Kirschvink, 1992, "Late Proterozoic Low-Latitude Global Glaciation: The Snowball Earth", *The Proterozoic Biosphere*, pp 51–52.
7. D. Raup & J. Sepkoski, 1982, "Mass extinctions in the marine fossil record", *Science*, vol. 215, pp. 1501–1503.
8. (U) OSINT Reports; *Natural History* (Vol. 125, issue 5, page 8); May 2017; (U) "Cooling Element"; UNCLASS; retrieved 24 April 2017.
9. (U) OSINT Reports; National Academies Press; **Biographical Memoirs V.74**; "Clair Cameron Patterson", by George R. Tilton, pp. 266-286; Unclass; ISBN 0-309-59186-4; (398 pages); (1998: Washington D.C.); retrieved 13 May 2016 using [redacted]
10. "Geodetic Reference System 1980 (GRS80)", *XVII General Assembly*, International Association of Geodesy.
11. T. H. Jordan, "Structural Geology of the Earth's Interior (http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=411539)", *Procedings National Academy of Science*, 1979, Sept., 76(9): 4192–4200.
12. Laskar, J., Robutel, P., Joutel, F., Gastineau, M., Correia, A.C.M., Levrard, B., 2004, "A long term numerical solution for the isolation quantities of the Earth (http://www.edpsciences.org/articles/aa/abs/2004/46/aa1335/aa1335.html)", *Astronomy and Astrophysics*, 428, pp. 261–285.
13. Jay M. Pasachoff and Alex Filippenko, *The Cosmos: Astronomy in the New Millenium,* Orlando: Harcourt, 2001: 187.
14. (U) OSINT Reports; *TIME* weekly news magazine; 27 January 2016; (U) This Is Why No One Can Own The Moon; UNCLASS; retrieved 17 FEB 2017.
15. (U) OSINT Reports; *New Statesman* magazine (Vol. 143, issue 5198, pp.24-27); 21 February 2014; (U) Lunar Land-Grab; UNCLASS; retrieved 17 FEB 2017.
16. (U) OSINT Reports; *Reuters News*; 3 February 2015; (U) Exclusive - The FAA: Regulating Business on the Moon; UNCLASS; retrieved 17 FEB 2017.
17. (U) OSINT Reports; *Mining Engineering*; January 2017; (U) Mining on the Moon - Yes, It's Really Going to Happen; UNCLASS; retrieved 17 FEB 2017.
18. "It's not lunacy, probes find water in Moon dirt (https://www.usatoday.com/tech/science/2009-09-23-moon-water_N.htm)", *USA Today*, 23 September 2009.
19. PSRD *CosmoSparks Report--An Icy Treat* (http://www.psrd.hawaii.edu/Archive/Archive-Moon.html)

(b)(3) - P.L. 86-36 [redacted]

20. Bill Keeter: http://www.nasa.gov/mission_pages/Mini-RF/multimedia/feature_ice_like_deposits.html NASA Radar Finds Ice Deposits at Moon's North Pole. NASA, March 2, 2010
21. BBC News Paul Rincon: Doubt cast on evidence for wet Moon (http://www.bbc.com/news/science-environment-26696856)
22. Shiklomanov, Igor A. 1993, "World fresh water resources", In *Water in crisis: A guide to the world's fresh water resources*, ed. Peter H. Gleick, 13–24. New York: Oxford University Press, ISBN 0195076273.
23. CIA: The World Factbook, "World (http://www.cia.gov/cia/publications/factbook/geos/xx.html)".
24. The average depth is, in fact, significantly greater than the statue of liberty. Letting the average depth be approximately equal to water volume divided by the Earth's surface area: the total volume of water is about 1.4×10^9 km^3; the total area of Earth is about 5.1×10^8 km^2. So the average depth would be roughly 2.8 km, whereas the statue of liberty is only 0.093 km, including the pedestal.
25. FAO, 1995, "United Nations Food and Agricultural Organization Production Yearbook", 49.
26. "Deep Ocean Studies" (http://www.rain.org/ocean/ocean-studies-challenger-deep-mariana-trench.html), RAIN National Public Internet and Community Technology Center. Date website accessed: 02 April 2006.
27. Leonard David, Planet's Population Hit 6.5 Billion Saturday (http://www.livescience.com/othernews/060224_world_population.html), Live Science, 24 February 2006.
28. Forrest J Ackerman, "Forrest J Ackerman's World of Science Fiction," RR Donnelley & Sons Company, Los Angeles, 1997. Pages 116–117. ISBN 1-57544-069-5.
29. Pale Blue Dot (http://gtrc911.quaker.org/pale_blue_dot.html), SETI@home. Date website accessed: 02 April 2006.
30. I.J. Sackmann, A.I. Boothroyd, K.E. Kraemer, "Our Sun. III. Present and Future. (http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=1993ApJ...418..457S)", *Astrophysical Journal*, vol. 418, pp. 457.
31. J.F. Kasting, 1988, "Runaway and Moist Greenhouse Atmospheres and the Evolution of Earth and Venus (http://adsabs.harvard.edu/abs/1988Icar...74..472K)", *Icarus*, 74, pp. 472–494.

External links

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- USGS Geomagnetism Program (http://geomag.usgs.gov)
- Overview of the Seismic Structure of Earth (PDF link)
- NASA Earth Observatory (http://earthobservatory.nasa.gov/Newsroom/BlueMarble)
- Beautiful Views of Planet Earth (http://www.funonthenet.in/content/view/282/31/) Pictures of Earth from space
- Java 3D Earth's Globe (http://www.professores.uff.br/hjbortol/arquivo/2006.1/applets/earth_en.html)
- Phases of the Moon Table [redacted]
- Projectshum.org's Earth fact file (http://www.projectshum.org/Planets/earth.html) (for younger folk)

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