Topic Page: Earth (Planet)

Image from: **Earth En route to the Moon in 1972 December, the...** in *Astronomy Encyclopedia*

Summary Article: **earth, in geology and astronomy**
From *The Columbia Encyclopedia*

in geology and astronomy, 3rd planet of the solar system and the 5th largest, the only planet definitely known to support life. Gravitational forces have molded the earth, like all celestial bodies, into a spherical shape. However, the earth is not an exact sphere, being slightly flattened at the poles and bulging at the equator. The equatorial diameter is c.7,926 mi (12,760 km) and the polar diameter 7,900 mi (12,720 km); the circumference at the equator is c.24,830 mi (40,000 km). The surface of the earth is divided into dry land and oceans, the dry land occupying c.57.5 million sq mi (148.9 million sq km), and the oceans c.139.5 million sq mi (361.3 million sq km). The earth is surrounded by an envelope of gases called the atmosphere, of which the greater part is nitrogen and oxygen.

The Geologic Earth

Knowledge of the earth's interior has been gathered by three methods: by the analysis of earthquake waves passing through the earth (see seismology), by analogy with the composition of meteorites, and by consideration of the earth's size, shape, and density. Research by these methods indicates that the earth has a zoned interior, consisting of concentric shells differing from one another by size, chemical makeup, and density. The earth is undoubtedly much denser near the center than it is at the surface, because the average density of rocks near the surface is c.2.8 g/cc, while the average density of the entire earth is c.5.5 g/cc.

The Earth's Crust and the Moho

The outer shell, or crust, varies from 5 to 25 mi (8 to 40 km) in thickness, and consists of the continents and ocean basins at the surface. The continents are composed of rock types collectively called sial, a classification based on their densities and composition. Beneath the ocean basins and the sial of continents lie denser rock types called sima. The sial and sima together form the crust, beneath which lies a shell called the mantle. The boundary between the crust and the mantle is marked by a sharp alteration in the velocity of earthquake waves passing through that region. This boundary layer is called the Mohorovičić discontinuity, or Moho.

The Earth's Mantle

Extending to a depth of c.1,800 mi (2,900 km), the mantle probably consists of very dense (average c.3.9 g/cc) rock rich in iron and magnesium minerals. Although temperatures increase with depth, the melting point of the rock is not reached because the melting temperature is raised by the great confining pressure. At depths between c.60 mi and c.125 mi (100 and 200 km) in the mantle, a plastic zone, called the asthenosphere, is found to occur. Presumably the rocks in this region are very close to melting, and the zone represents a fundamental boundary between the moving crustal plates of the earth's surface and the interior regions. The molten magma that intrudes upward into crustal rocks or issues from a volcano in the form of lava may owe its origin to radioactive heating or to the relief of pressure in the lower crust and upper mantle caused by earthquake faulting of the overlying crustal rock. Similarly, it is thought that the heat energy released in the upper part of the mantle has broken the earth's crust into vast plates that slide around on the plastic zone, setting up stresses along the

plate margins that result in the formation of folds and faults (see plate tectonics). The lower mantle, between c.410 and 1,800 mi (660 to 2,900 km), consists largely (70%) of high-density magnesium iron silicate called bridgmanite, believed to be the most abundant mineral on earth.

The Earth's Core

Thought to be composed mainly of iron and nickel, the dense (c.11.0 g/cc) core of the earth lies below the mantle. The abrupt disappearance of direct compressional earthquake waves, which cannot travel through liquids, at depths below c.1,800 mi (2,900 km) indicates that the outer 1,380 mi (2,200 km) of the core are molten. The inner 780 mi (1,260 km) of the core are solid, and the innermost 190 mi (300 km) of that may be almost pure iron; the crystals of the innermost portion appear to be aligned along the plane of the equator, but those of the rest of the inner core appear to be aligned along the plane of the axis. The outer core is thought to be the source of the earth's magnetic field: In the “dynamo theory” advanced by W. M. Elasser and E. Bullard, tidal energy or heat is converted to mechanical energy in the form of currents in the liquid core; this mechanical energy is then converted to electromagnetic energy, which we see as the magnetic field. The magnetic field undergoes periodic reversals of its polarity on a timescale that ranges from a few thousand years to 35 million years. The last reversal occurred some 780,000 years ago.

The Astronomical Earth

Of the planets, only Mercury and Venus are nearer to the sun; the mean distance from the earth to the sun is c.93 million mi (150 million km).

Rotation and Revolution

The earth rotates from west to east about a line (its axis) that is perpendicular to the plane of the equator and passes through the center of the earth, terminating at the north and south geographical poles. The period of one complete rotation is a day; the rotation of the earth is responsible for the alternate periods of light and darkness (day and night). The earth revolves about the sun once in a period of a little more than 365 1/4 days (a year). The path of this revolution, the earth's orbit, is an ellipse rather than a circle, and the earth is consequently nearer to the sun in January than it is in July; the difference between its maximum and minimum distances from the sun is c.3 million mi (4.8 million km). This difference is not great enough to affect climate on the earth.

The Change in Seasons

The change in seasons is caused by the tilt of the earth's axis to the plane of its orbit, making an angle of c.66.5°. When the northern end of the earth's axis is tilted toward the sun, the most direct rays of sunlight fall in the Northern Hemisphere. This causes its summer season. At the same time the Southern Hemisphere experiences winter since it is then receiving indirect rays. Halfway between, in spring and in autumn, there is a time (see equinox) when all parts of the earth have equal day and night. When the northern end of the earth's axis is tilted away from the sun, the least direct sunlight falls on the Northern Hemisphere. This causes its winter season.

The Origin of the Earth

The earth is estimated to be about 4.54 billion years old, based on radioactive dating of lunar rocks and meteorites, which are thought to have formed at the same time. The origin of the earth continues to be controversial. Among the theories as to its origin, the most prominent are gravitational condensation hypotheses, which suggest that the entire solar system was formed at one time in a

single series of processes resulting in the accumulation of diffuse interstellar gases and dust into a solar system of discrete bodies. The generally accepted theory of the moon's formation hypothesizes that the early earth was impacted by a Mars-sized object, and that the collision ejected material that later formed the moon. Older and now generally discredited theories of the earth's formation invoked extraordinary events, such as the gravitational disruption of a star passing close to the sun or the explosion of a companion star to the sun.

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