Earth science

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Earth science (also known as **geoscience, the geosciences** or **the Earth Sciences**), is an all-embracing term for the sciences related to the planet Earth.[1] It is arguably a special case in planetary science, the Earth being the only known life-bearing planet. There are both reductionist and holistic approaches to Earth science. There are four major disciplines in earth sciences, namely geography, geology, geophysics and geodesy. These major disciplines use physics, chemistry, biology, chronology and mathematics to build a quantitative understanding of the principal areas or *spheres* of the Earth system.

Contents

A volcano eruption is the release of stored energy from below the surface of Earth, originating from radioactive decay and gravitational sorting in the Earth's core and mantle, and residual energy gained during the Earth's formation.[2]

Fields of study

Lava flows from the Kīlauea volcano into the ocean on the Island of Hawaii

The following fields of science are generally categorized within the geosciences:

- Geology describes the rocky parts of the Earth's crust (or lithosphere) and its historic development. Major subdisciplines are mineralogy and petrology, geochemistry, geomorphology, paleontology, stratigraphy, structural geology, engineering geology and sedimentology[3][4].
- Geophysics and Geodesy investigate the figure of the Earth, its reaction to forces and its magnetic and gravity fields. Geophysicists explore the Earth's core and mantle as well as the tectonic and seismic activity of the lithosphere[4][5][6].
- Soil science covers the outermost layer of the Earth's crust that is subject to soil formation processes (or pedosphere)[7]. Major subdisciplines include edaphology and pedology[8].

- Oceanography and hydrology (includes limnology) describe the marine and freshwater domains of the watery parts of the Earth (or hydrosphere). Major subdisciplines include hydrogeology and physical, chemical, and biological oceanography.
- Glaciology covers the icy parts of the Earth (or cryosphere).
- Atmospheric sciences cover the gaseous parts of the Earth (or atmosphere) between the surface and the exosphere (about 1000 km). Major subdisciplines are meteorology, climatology, atmospheric chemistry and atmospheric physics.
- A very important linking sphere is the biosphere, the study of which is biology. The biosphere consists of all forms of life, from single-celled organisms to pine trees to people. The interactions of Earth's other spheres - lithosphere/geosphere, hydrosphere, atmosphere and/or cryosphere and pedosphere - create the conditions that can support life.

Earth's interior

Plate tectonics, mountain ranges, volcanoes, and earthquakes are geological phenomena that can be explained in terms of energy transformations in the Earth's crust.[9]

Beneath the Earth's crust lies the mantle which is heated by the radioactive decay of heavy elements. The mantle is not quite solid and consists of magma which is in a state of semi-perpetual convection. This convection process causes the lithospheric plates to move, albeit slowly. The resulting process is known as plate tectonics.[10][11][12][13]

Plate tectonics might be thought of as the process by which the earth resurfaces itself. Through a process called *spreading ridges* (or seafloor spreading), the earth creates new crust by allowing magma underneath the lithosphere to come to the surface where it cools and solidifies--becoming new crust, and through a process called subduction, excess crust is pushed underground--beneath the rest of the lithosphere--where it comes into contact with magma and melts--rejoining the mantle from which it originally came.[11][13][14]

Areas of the crust where new crust is created are called *divergent boundaries*, and areas of the crust where it is brought back into the earth are called *convergent boundaries*.[15][16] Earthquakes result from the movement of the lithospheric plates, and they often occur near covergent boundaries where parts of the crust are forced into the earth as part of subduction.[17]

Volcanoes result primarily from the melting of subducted crust material. Crust material that is forced into the Asthenosphere melts, and some portion of the melted material becomes light enough to rise to the surface--giving birth to volcanoes.[11][17]

Earth's electromagnetic field

An electromagnet is a magnet that is created by a current that flows around a soft-iron core.[18] Earth has a soft iron core surrounded by semi-liquid materials from the mantle that move in continuous currents around the core;[19] therefore, the earth is an electromagnet. This is referred to as the dynamo theory of Earth's magnetism.[20][21] The fact that Earth is an electromagnet helps it maintain an atmosphere suitable for life.

Atmosphere

Earth is blanketed by an atmosphere consisting of 78.0% nitrogen, 20.9% oxygen, and 1% Argon.[22] The atmosphere has five layers: troposphere, stratosphere, mesosphere, thermosphere, and exosphere; and 75% of the atmosphere's gases are in the bottom-most layer, the troposphere.[22]

The magnetic field created by mantle's internal motions produces the magnetosphere which protects the Earth's atmosphere from the solar wind.[23] It is theorized that the solar wind would strip away earth's atmosphere in a few million years were it not for the Earth's electromagnet. And since earth is 4.5 billion years old,[24] earth would not have an atmosphere by now if there were no magnetosphere.

The atmosphere is composed of 78% nitrogen and 21% oxygen. The remaining one percent contains small amounts of other gases including CO_2 and water vapors.[22] Water vapors and CO_2 allow the Earth's atmosphere to catch and hold the sun's energy through a phenomenon called the greenhouse effect.[25] This allows earth's surface to be warm enough to have liquid water and support life.

In addition to storing heat, the atmosphere also protects living organisms by shielding the Earth's surface from cosmic rays. Note that the level of protection is high enough to prevent cosmic rays from destroying all life on Earth, yet low enough to aid the mutations that have an important role in pushing forward diversity in the biosphere.

Methodology

Like all other scientists, Earth scientists apply the scientific method. They formulate hypotheses after observing events and gathering data about natural phenomena, and then they test hypotheses from such data.

A contemporary idea within earth science is uniformitarianism. Uniformitarianism says that "ancient geologic features are interpreted by understanding active processes that are readily observed". Simply stated, this means that features of the Earth can be explained by the actions of gradual processes operating over long periods of time; for example, a mountain need not be thought of as having been created in a moment, but instead it may be seen as the result of continuous subduction, causing magma to rise and form continental volcanic arcs.

Earth's spheres

Earth science generally recognizes 4 spheres, the lithosphere, the hydrosphere, the atmosphere, and the biosphere[26]; these correspond to rocks, water, air, and life. Some practitioners include, as part of the spheres of the Earth, the cryosphere (corresponding to ice) as a distinct portion of the hydrosphere, as well as the pedosphere (corresponding to soil) as an active and intermixed sphere.

Partial list of the major earth science topics

See: List of basic earth science topics

Atmosphere

- Atmospheric chemistry
- Climatology
- Meteorology
  - Hydrometeorology

- Paleoclimatology

Biosphere

- Biogeography
- Paleontology
  - Palynology
  - Micropaleontology
- Geomicrobiology

Hydrosphere

- Hydrology
  - Limnology
- Hydrogeology
- Oceanography
  - Chemical oceanography
  - Marine biology
  - Marine geology
  - Paleoceanography
  - Physical oceanography

Lithosphere or geosphere

- Geology
  - Economic geology
  - Engineering geology
  - Environmental geology
  - Historical geology
    - Quaternary geology
  - Planetary geology
  - Sedimentology
  - Stratigraphy
  - Structural geology
- Geography
  - Physical geography
- Geochemistry
- Geomorphology
- Geophysics
  - Geochronology
  - Geodynamics (see also Tectonics)
  - Geomagnetics
  - Gravimetry (also part of Geodesy)
  - Seismology
- Glaciology
- Hydrogeology
- Mineralogy
  - Crystallography
  - Gemology
- Petrology
- Speleology
- Volcanology

Pedosphere

- Soil science
  - Edaphology
  - Pedology

Systems

- Environmental science
- Geography
  - Human geography
  - Physical geography

- Gaia hypothesis

Others

- Cartography
- Geoinformatics (GIS)
- Geostatistics
- Geodesy and Surveying
- NASA Earth Science Enterprise