

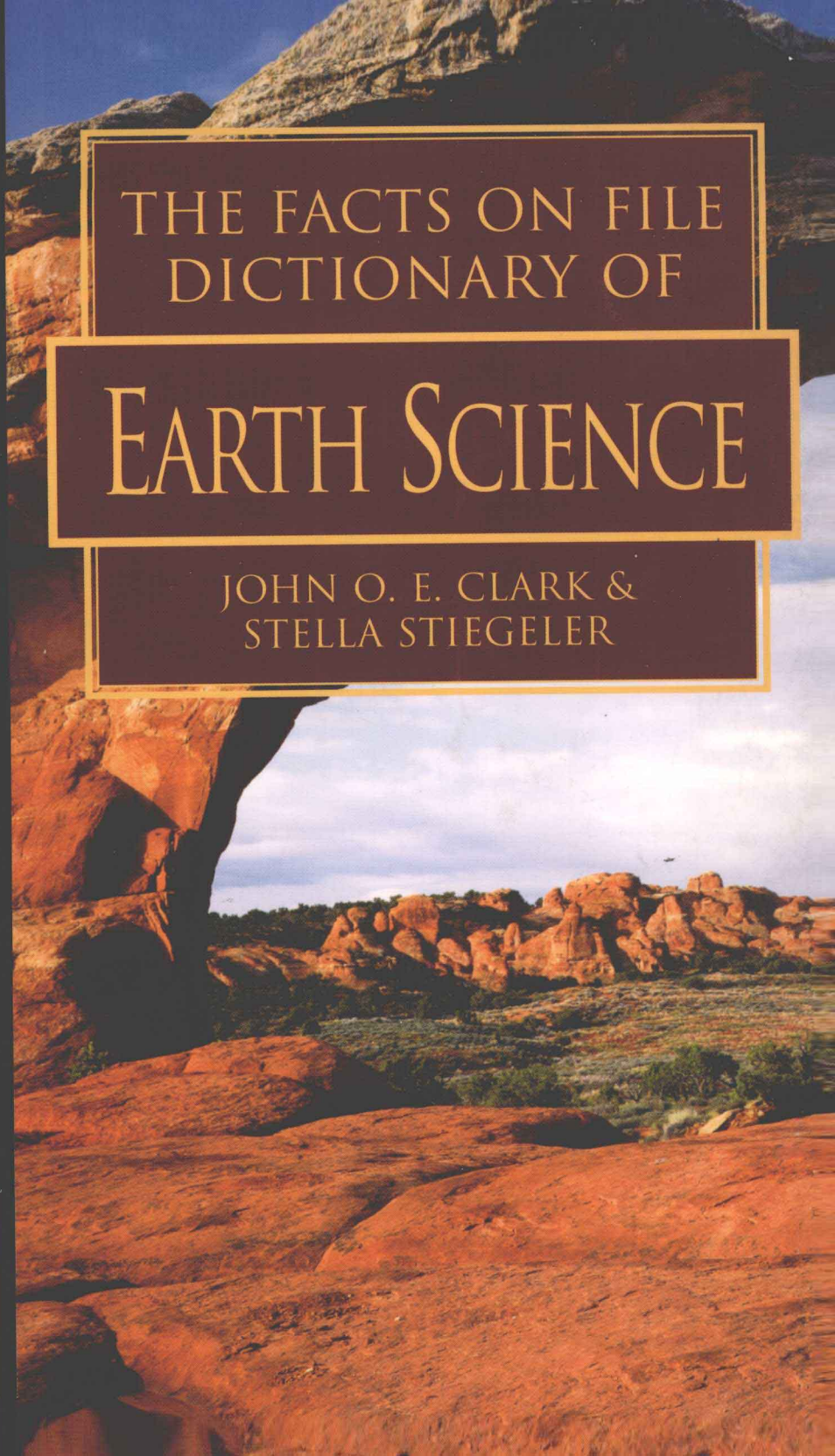
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THE FACTS ON FILE  
DICTIONARY OF

# EARTH SCIENCE

JOHN O. E. CLARK &  
STELLA STIEGELER



The Facts on File  
**DICTIONARY**  
of  
**EARTH SCIENCE**

Edited by  
John O. E. Clark  
Stella Stiegeler



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## The Facts On File Dictionary of Earth Science

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**DICTIONARY**  
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**EARTH SCIENCE**

## FOREWORD

This dictionary is one of a series designed for use in schools. It is intended for students of earth sciences, but we hope that it will also be helpful to other science students and to anyone interested in science. The other books in the series are *The Facts On File Dictionary of Biology*, *The Facts On File Dictionary of Chemistry*, *The Facts On File Dictionary of Physics*, *The Facts On File Dictionary of Mathematics*, *The Facts On File Dictionary of Computer Science*, and *The Facts On File Dictionary of Astronomy*.

This book is based on an edition first published by the Macmillan Press in 1976. This edition has been extensively revised and extended. The dictionary now contains over 3400 headwords covering the terminology of modern earth science. A short Appendix of chemical elements is included.

We would like to thank all the people who have cooperated in producing this book. A list of contributors is given on the acknowledgments page. We are also grateful to the many people who have given additional help and advice.

## ACKNOWLEDGMENTS

### *Editor (First Edition)*

Stella Stiegeler B.Sc.

### *Contributors*

B. M. Abbott B.Sc., Ph.D., F.G.S.  
Anna Clyde B.Sc.  
Andrew Hill B.Sc., Ph.D., F.G.S.  
I. P. Joliffe B.Sc., M.Sc, Ph.D., C.I.C.E., F.C.S., F.R.G.S.  
R. B. Lanwarne B.Sc.  
P. A. Smithson B.Sc., Ph.D., F.R.Met.S.  
T. J. Speechley B.Sc.  
F. A. Sultan B.Sc., M.Sc., D.I.C.  
S. D. Weaver B.Sc., Ph.D., F.G.S.  
A. C. Wornell B.A.

**aa** A LAVA with an extremely rough spinose surface. *Compare* block lava; pahoehoe.

**Aalenian** The earliest part of the Middle JURASSIC period.

**abandoned cliff** *See* cliff.

**abiotic** Describing a nonliving factor in an ECOSYSTEM. Light, rainfall, soil type, and temperature are all abiotic factors. Chemical residues from artificial fertilizers and pollution constitute harmful abiotic factors. *See also* biotic.

**ablation** The disappearance of snow and ice by melting and evaporation. This can refer to ice crystals or snow flakes in the atmosphere but is most commonly used for glacier ice and surface snow cover, when it can also include avalanching. The rate of ablation is primarily controlled by air temperature but sunshine, rainfall, humidity, and wind speed also affect the process.

**ablation cone** A cone of FIRN, ice, or snow covered in rock debris caused by differential ABLATION.

**ablation moraine** Debris of rock fragments left at the side of a glacier following ABLATION.

**ablation till** TILL material formerly present on the surface of glaciers and subsequently deposited as a result of the melting of the ice beneath. These deposits tend to contain relatively little fine material because this may be removed by meltwater prior to deposition. *Compare* lodgment till.

**Abney level** A simple surveying instrument for measuring slope angles. The level is held by hand, objects being viewed through a sighting tube. The observer may stand at the top or bottom of a slope, but must sight onto a point at a height equivalent to his or her eye-level. Once an object is sighted, adjustment is made to a tilting spirit level, an image of the bubble being visible in the sighting tube. When the bubble image coincides with the object sight the angle of slope can be read off an attached scale, which is provided with a vernier to permit reading down to ten minutes of arc. The instrument is not very accurate, but is small and quick to use.

**abnormal erosion** (accelerated erosion) Erosion acting faster than normal as a result of the removal of the vegetation cover by human agencies. It is abnormal in the sense that it is superimposed upon natural processes. *See also* blowout; human influence on geomorphology.

**abrasion** The wearing away of rocks by an agent of transportation charged with a load of already eroded material, which acts as a tool for cutting, grinding, scratching, and polishing. All the major transportation agents (running water, wind, moving ice, and sea waves and currents) can abrade so long as they carry debris. Abrasion by water and ice characteristically produces rounded forms, and abrasion by ice also produces striations, while the sand-blasting effect of wind abrasion is most effective in a narrow zone just above ground level, resulting in undercut features. As abrasion takes place, the corresponding reduction in size of the initial load debris is known as ATTRITION. A distinction is sometimes made between abrasion and CORRASION,

which refers to the erosional processes that result in abraded rock surfaces.

**abrasion platform** A gently sloping ledge of rock at the base of a steep cliff extending from the high-tide level to the low-tide level. It is caused by ABRASION by waves at the base of the cliff, where undercutting results in rock falls from above. It is also called a wave-cut platform.

**absolute age** The age of a fossil, rock formation, or individual rock, usually stated in years. Such ages are usually determined by DENDROCHRONOLOGY or RADIO-METRIC DATING. *See also* relative dating.

**absolute drought** A prolonged period (usually at least 15 days) during which no more than 0.25 mm of rain falls on any day.

**absolute humidity** The mass of water vapor in a unit volume of air (usually stated in units of  $\text{g m}^{-3}$  or  $\text{kg m}^{-3}$ ). It depends on the temperature and pressure of the air. *See* humidity.

**absolute temperature** A temperature scale based on the coldest temperature that is physically possible. This absolute zero of temperature is  $-273.15^\circ\text{C}$ , but for meteorological purposes the absolute temperature is taken as the Celsius temperature plus  $273^\circ$ , so that the freezing point of water is  $273^\circ$  and boiling point  $373^\circ$ . Formerly measured in degrees absolute ( $^\circ\text{A}$ ), it is now measured in KELVINS.

**absorption** (in meteorology) The conversion of short- or long-wave radiation to a different form of energy by gases in the atmosphere. Absorption is highly selective in terms of wavelength; some wavelengths are entirely absorbed and others are totally unaffected. The main atmospheric gases, oxygen and nitrogen, are not very important as absorbers of radiation, but minor gases such as carbon dioxide, water vapor, ozone, and nitrous oxide have a significant effect. *See also* atmospheric window.

**abstraction** 1. The fraction of PRECIPITATION

that does not immediately run off. It is absorbed, evaporated, stored, or transpired.

2. The union of two streams resulting from erosion of the land (DIVIDE) between them. It generally occurs in gullies and ravines.

**abyss** *See* deep.

**abyssal hill** A large dome-shaped submarine hill on the ABYSSAL PLAIN. Such hills rise to heights of 1000 m in up to 6000 m of water and may be several kilometers wide. There are many along the MID-ATLANTIC RIDGE and in the Pacific Ocean.

**abyssal plain** An extremely smooth portion of the deep-sea floor. The gradients across abyssal plains fall within the range of 1:1000 to 1:10 000, which means that variations in depth amount to only a few meters. This remarkable degree of flatness has come to light because of deep-sea photographs and high-precision sounding techniques. In the Atlantic Ocean, abyssal plains range between 200 and 400 kilometers in width, but they can be several hundred kilometers wide. They tail upwards into the continental rise and frequently, in a seaward direction, merge into abyssal hills. Their sediments are varied; while most are thinly veneered with pelagic sediment, perhaps globigerina ooze and red clay, they also display sediments and plant and animal remains that normally characterize shallow-water environments. The reason for this may be the operation of TURBIDITY CURRENTS.

**abyssal rock** A type of intrusive igneous rock formed deep within the Earth's crust.

**abyssal zone** A zone of greatest ocean depth, lying seaward of and deeper than the BATHYAL ZONE of the continental slope, that is below a depth of some 1000 m, and including the deeper parts of the oceans and the deep-sea trenches. Lying between the abyssal and bathyal zones is the CONTINENTAL RISE, which is often bordered on its seaward flank by abyssal plains and abyssal hills. The pelagic-abyssal environment (*see* pelagic (def. 1)), which is not



reached for at least several hundred kilometers from the coast, globally represents an area of  $250 \times 10^6$  sq km, i.e. roughly half the area of the Earth. Few organisms live in these depths, where pressure is high and light does not reach, and deposition of sediment is very slow.

**accelerated erosion** See abnormal erosion.

**acceleration of free fall** (acceleration due to gravity) The acceleration (g) of a body falling freely in a vacuum in the Earth's gravitational field. The standard value is  $9.80665 \text{ m s}^{-2}$ , although actual values depend on the distance from the Earth's center of mass.

**accessory mineral** A mineral that is present in small quantities in a rock and does not affect the overall character of that rock for classification purposes.

**acclimatization** The process by which humans become adapted to living in a markedly unfamiliar climatic regime. This normally refers to a change to hot and humid or especially cold climatic conditions. If acclimatization has not taken place, severe physiological stress may result. The full process may take up to ten years.

**accordant** (conformable) Describing a drainage pattern that is controlled by the structures over which it flows. Actual patterns vary greatly, depending on the nature of the structures or lithologies. *Compare* discordant (def. 2).

**accordian folding** A type of folding in rocks, in which the beds of the hinge area are markedly thickened and sharply folded, while on the limbs the beds are straight and of uniform thickness.

**accretion** 1. The process of ice crystal growth by collision with water droplets in clouds. This is one of the mechanisms by which minute cloud droplets achieve sufficient size to give rainfall.  
2. See nucleation.

**accumulated temperature** A method of indicating the excess or deficit of temperature with reference to a specified value for a specified period. Two temperature bases that have been frequently used are  $6^\circ\text{C}$  for the commencement of plant growth and  $16^\circ\text{C}$  for heating requirements. The accumulated temperature is calculated by taking the number of hours in a specific period the temperature was above or below the set value and multiplying by the mean temperature during this time to give the number of degree hours. More commonly, daily or monthly values of accumulated temperature are obtained from daily or mean values rather than hourly ones.

**accumulation** 1. The total amount of PRECIPITATION that gathers on a snowfield or glacier.

2. The overall result of all processes that add mass to a snowfield, glacier, or ice floe, including snow from avalanches, snowfall, and windblown snow.

**achnelichs** Fragments of glassy smooth PYROCLASTIC ROCK derived from basaltic LAVA that has sprayed in the air while molten and solidified. Pele's tears are achnelichs.

**achondrite** A stony meteorite that does not contain CHONDRULES. *Compare* chondrite.

**acicular** Describing a crystal having a needle-like habit. *See* crystal habit.

**acid brown soil** A type of soil found in the BROWN EARTH zone on base-deficient parent materials. Such soils are strongly acid, with a moder humus, and although the B horizon is more clearly differentiated by color than in the true brown earth there is no appreciable eluviation of clay or iron oxides. With time it seems likely that these soils would become podzolic brown earths.

**acid lava** Slow-moving viscous LAVA containing a high proportion of silica. Produced by so-called acidic volcanoes, it generally solidifies very quickly. *See also* basic lava.

## acid rain

**acid rain** Any PRECIPITATION (including fog, rain, sleet, and snow) that is acidic due to the presence of sulfur dioxide and nitrogen oxides in the atmosphere. Most of these pollutants derive from the burning of FOSSIL FUELS. Acid rain kills trees, poisons rivers and lakes, and corrodes buildings. Runoff of acid rain affects the mineral composition of the soil.

**acid rock** The dominant chemical constituent of igneous rocks is silica,  $\text{SiO}_2$ , which typically ranges from 35–75% (by weight). Arbitrary divisions are made as follows: acid –  $\text{SiO}_2 > 66\%$ , intermediate –  $\text{SiO}_2$  55–66%, basic –  $\text{SiO}_2$  45–55%, and ultrabasic –  $\text{SiO}_2 < 45\%$ . These strict divisions have been largely abandoned but the general descriptive terms acid, basic, etc., remain. In current usage, an acid rock contains in excess of about 10% free QUARTZ, e.g.: granite, granodiorite, rhyolite.

**acid soil** Soil acidity is measured on the pH scale, which is related to the concentration of hydrogen ions in the soil. A neutral soil is given a pH value of 7.0; if the value is less than this it is termed an acid soil and if greater an alkaline soil. Thus there is an inverse relationship between pH value and the concentration of hydrogen ions. Acid soils develop where, for some reason, there is a lack of the exchangeable bases in the soil, such as calcium and sodium. The bases have been largely replaced by the two cations hydrogen and aluminum, which control soil acidity. Possible acid-forming factors are leaching, organic matter containing few bases, and an acid parent material. Acid soils are therefore particularly common in the humid tropics and the humid temperate lands. Examples of typical acid soils are podzols, brown earths, and latosols. From the agricultural viewpoint most cultivated crops will thrive on mildly acid soils.

**acmite** (aegirine) *See* pyroxene.

**acre** A unit of area equal to 4840 yd<sup>2</sup> (equivalent to 4046.86 m<sup>2</sup> or 0.4047 hectares).

**acre foot** A unit of volume equal to an area of 1 acre to a depth of 1 foot (equivalent to 43 560 ft<sup>3</sup> or 1233.5 m<sup>3</sup>). It is used for expressing the volumes of lakes and reservoirs.

**actinolite** A monoclinic AMPHIBOLE.

**actinomycetes** Aerobic bacteria that have a filamentous habit as do fungi. Optimum conditions are a moist well-aerated soil with a pH between 6.0 and 7.5. They are more prolific than other bacteria and fungi in drier areas and are important also in that they can decompose the more resistant soil organic matter.

**Actinopterygii** Ray-finned bony fish in which the paired fins are not fleshy (*compare* Crossopterygii) but have narrow bases and are supported by thin fin rays. The Actinopterygii also have a single dorsal fin. The group includes the modern TELEOSTEI. *See also* Osteichthyes.

**active layer** *See* permafrost.

**actualism** *See* uniformitarianism.

**actuopaleontology** The branch of paleontology in which investigations into modern organisms, including their effects and remains in modern environments, are directed toward the understanding of fossil analogs. Based upon uniformitarian principles (*see* uniformitarianism), actuopaleontology provides a means of relating various TRACE FOSSILS. to the particular animals from which they are derived and of understanding the changes that an organism undergoes between death and fossilization (*see* taphonomy; thanatocoenosis). BIOSTRATONOMY is one aspect of actuopaleontology.

**adamantine** Describing a mineral that has a brilliant diamondlike luster.

**adamellite** A variety of granite consisting of about equal proportions of potassium feldspar and sodic plagioclase feldspar together with one or more ferromagnesian minerals.

**adiabatic** Denoting an atmospheric process in which there is no exchange of heat between the system and its environment. In the more rapid exchanges, such as thermals rising from the ground surface, this is a reasonable approximation. In these circumstances, the change in temperature of rising air is determined by the physical properties of the air and the external pressure. As air pressure decreases with height above the ground surface, rising air expands, and exerts mechanical work on its environment. This necessitates a loss of heat energy from the rising air and its temperature falls. The rate of fall of temperature in an adiabatic process is constant for our atmospheric composition, being  $0.98^{\circ}\text{C}/100$  meters, and is known as the DRY ADIABATIC LAPSE RATE.

**adit** A horizontal or slightly upward-sloping closed-ended passage into a mine, usually constructed to intersect a seam of coal or vein of mineral. The slope is to ensure that any water drains out of the adit.

**adjacent seas** Marginal seas and inland seas. They lie adjacent to the oceans but generally they are much smaller. Because many adjacent seas are largely encircled by land, the characteristics of the water and sediments they contain, and to a certain extent their topography, are strongly influenced by the landmass, for example in the amounts and nature of terrigenous sediments transported down rivers to the coast and the climatic effects associated with the land-sea margin.

**adobe** A mixture of silt and clay, common in Mexico and the southwestern USA. It has long been used for making bricks because it dries to a hard weatherproof mass. *See also* loess.

**adret** The sunny or, in the N hemisphere, south-facing slope of a valley. It is the side favored for farming, as in the European Alps.

**adularia** A variety of alkali FELDSPAR.

**advection** The horizontal component in the transfer of air properties. For example, the heat and water vapor content of the air at the Earth's surface varies appreciably and by the wind systems these properties are transferred to other areas. With winds from tropical latitudes there is advection of warm air, and from polar latitudes, advection of cold air.

**advection fog** Fog formed by the horizontal transfer of moist air over a cold surface, which sufficiently cools the lower layers of the atmosphere to give saturation and condensation. In summer it occurs over cool seas, such as the North Sea, the Labrador area, and off the coast of California, frequently affecting the adjacent coasts. In winter the advection of warm moist air over a cold snow-covered ground can also produce this type of fog.

**aegirine** (acmite) A sodic clinopyroxene. *See* pyroxene.

**aegirine-augite** *See* pyroxene.

**aeolian erosion** The direct erosive action of wind. This is the least important aspect of wind action, generally of little consequence in landscape formation when compared with the role of wind transport and deposition. Sand blast, from the impact of saltating grains, is limited to below one meter or so from the ground surface; it can undercut rocks leaving pedestals, although in some instances increased weathering at the foot of the rock weakens it beforehand. More significant than aeolian erosion by abrasion is the production of DEFLATION hollows. These can reach 100 km across, and although partly due in some cases to faulting or rock solution, they are mainly due to wind removal of preweathered material down to the water table, which halts further removal and produces OASES.

**aeolian form** A landform produced by material transported by wind. Large-scale features include dunes, sand shadows, and sand sheets, while small-scale features include sand ripples and ridges. Sand shad-

ows, unlike true dunes, are deposited in the shelter of an obstacle, while sand sheets or seas are amorphous sheets with gentle swellings reaching 3–6 meters. Ripples are the products of irregularities in the surface over which the sand is passing: these initiate local concentrations of sand grain impacts on the slopes facing the wind, which become built up as ripples. Further, each ripple acts as a take-off point for grains in SALTATION, and since the average length of travel per jump is related to wind speed, an even repetition of areas of concentrated grain impacts occurs downwind, leading to regular ripple patterns.

**aeolian transport** The movement of sediment by wind. Below a threshold of 16 km per hour wind is incapable of moving sand, but thereafter sand movement rises as a cubic function of wind speed. Short periods of high-velocity winds are therefore very much more effective than longer periods of gentle winds.

Aeolian transport takes place concurrently in three forms: suspension, SALTATION, and surface creep. A small proportion of grains of less than 0.2 mm in diameter can be carried wholly in suspension; the particle is totally buoyed up by the rising eddies in the air and carried along parallel to the air stream. Surface creep accounts for about 25% of actual sand movement, and involves the movement of grains of coarse sand along the surface by the impact of the saltating grains. Saltation accounts for about 75% of sand flow and involves the bouncing of grains along the surface at heights of less than 1 meter, and mostly within 200 mm of the ground surface.

**aerodynamic roughness** An index of the nature of airflow near the ground surface. A surface is aerodynamically smooth if there is a layer of air immediately above it that has laminar flow. However, in meteorological terms, nearly all surfaces are aerodynamically rough, producing turbulent flow down to the ground surface, even for the lightest winds.

**aerolite** A stony METEORITE made up of silicate minerals.

**aeronautical chart** A form of map produced essentially for air navigation or pilotage. In addition to showing the relevant topographical features, such as contours, vegetation, roads, and cultural detail, the map shows supplementary information for specialized use, such as detailed vertical obstruction information, flight areas, air corridors, etc.

**aeronomy** The science of the upper atmosphere, where dissociation and ionization of gas molecules takes place. The lower limit for these processes to occur is about 30 km. As the relationships between the upper and lower atmosphere are as yet little understood, there has been considerable research recently into the possible effects of these upper levels in tropospheric weather.

**aerosol** A particle of matter that is larger than a molecule but small enough to remain suspended in the atmosphere. Aerosols may be solid or liquid and play an important part in many atmospheric processes, such as precipitation formation, atmospheric electrification, radiation balances, and visibility. The origins of aerosols are diverse. Over sea areas, sea spray provides large salt nuclei and over land, weathering dusts of clay particles are probably the major source.

**afforestation** The large-scale planting or replanting of trees. They may be planted to prevent soil EROSION, to act as WIND-BREAKS, or as a source of timber (usually for wood pulp).

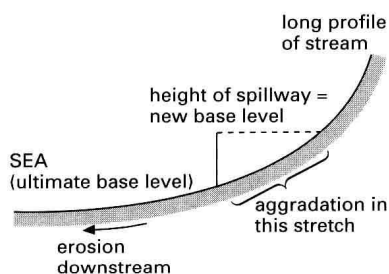
**aftershocks** A series of minor shocks or vibrations that follow the main series of earthquake shocks. In general they originate at or near the focus of the main earthquake as a result of the readjustment of rocks that have over-reacted during the main period of movement. Depending upon the size of the earthquake they can continue for a few days or months.

**agate** An extremely fine-grained type of QUARTZ consisting of alternate bands of colored CHALCEDONY. It may be white, gray, red, brown, or black, and can be dyed other colors. It generally occurs in rock cavities. It is used for making ornaments and as a semiprecious gemstone. *See also* moss agate; silica minerals.

**age** An interval of geologic time in the Chronomeric Standard scale of chronostratigraphic classification (*see* chronostratigraphy). The equivalent Stratomeric Standard term, indicating the body of rock formed during this time, is the STAGE. Ages may be grouped together to form EPOCHS and may themselves be comprised of several CHRONS.

**ageostrophic wind** The vector difference between the actual wind and the geostrophic wind. Without an ageostrophic component there would be no changes in pressure systems and atmospheric circulation would be a perfect balance between the pressure gradient and the CORIOLIS EFFECT.

**agglomerate** A mixture of coarse angular fragments of rock and finer-grained material formed during a volcanic explosion. *See* pyroclastic rock.



Aggradation in a dammed stream

**aggradation** The raising of the level of the land surface, especially by rivers. The cause of aggradation is incompetence (*see* competence) or incapacity (*see* capacity) of the river to transport its load, leading to deposition. This may arise through an in-

crease in the volume of load supplied to the river, a loss of speed or volume of flow, or most commonly a rise in base level. Another common cause of aggradation is the damming of a stream, artificially creating a new base level for the upper reaches of a river. Originally graded to sea level, the upper reaches will aggrade to the new base level, the height of the dam's spillway. *See also* degradation.

**aggregate** Mineral fragments and/or rock particles that combine to form a hard mass.

**agmatite** A MIGMATITE in which melanocratic material occurs as angular inclusions in a leucocratic granitic host, giving an overall appearance resembling a breccia.

**Agnatha** Primitive jawless fish, from which all more advanced vertebrate types have presumably evolved. Modern species are few and represent groups unknown as fossils. The diverse extinct forms can be grouped together as the OSTRACODERMI, which were abundant in the Silurian and Devonian and are used in stratigraphic CORRELATION. *Compare* Gnathostomata.

**agonic line** A line joining all points on the surface of the Earth where the ANGLE OF DECLINATION is zero. Along such a line, magnetic north and true north coincide. *See also* isogon.

**A horizon** The uppermost layer of soil, or topsoil. It consists of fine soil particles and HUMUS. Some soluble material will have been dissolved out and passed downward to the B HORIZON beneath. *See also* horizon.

**air** The mixture of gases in the atmosphere. Its composition is almost uniform throughout the troposphere and is shown in the table overleaf. Only water vapor and carbon dioxide vary appreciably, the former in relation to evaporation and precipitation and the latter through plant photosynthesis.

COMPOSITION OF AIR  
(% by volume)

nitrogen	(N <sub>2</sub> )	78.08
oxygen	(O <sub>2</sub> )	20.95
carbon dioxide	(CO <sub>2</sub> )	0.03
argon	(Ar)	0.93
neon	(Ne)	$1.82 \times 10^{-3}$
helium	(He)	$5.24 \times 10^{-4}$
methane	(CH <sub>4</sub> )	$1.5 \times 10^{-4}$
krypton	(Kr)	$1.14 \times 10^{-4}$
xenon	(Xe)	$8.7 \times 10^{-5}$
ozone	(O <sub>3</sub> )	$1 \times 10^{-5}$
nitrous oxide	(N <sub>2</sub> O)	$3 \times 10^{-5}$
water	(H <sub>2</sub> O)	variable, up to 1.00
hydrogen	(H <sub>2</sub> )	$5 \times 10^{-5}$

**air-fall deposit** A sediment composed of fallout from a cloud of airborne material from an erupting volcano, as opposed to LAVA (which generally flows from a volcano).

**air mass** An area of the lower atmosphere with similar properties of temperature and moisture in the horizontal field. At the margins of the air mass, temperature gradients become steep at a transition zone known as a FRONT. The uniformity of properties is achieved by prolonged contact with the underlying surface and little horizontal or vertical mixing. These requirements are experienced in areas of high pressure or anticyclones, which are the main source areas for air masses. Away from their source areas, air masses undergo modification by coming in contact with different surfaces with the result that in a short period of time they can become indistinguishable. As most parts of the world represent modification zones rather than source areas, air mass terminology is less frequently used than formerly. There have been many attempts to classify air masses, but the most frequently quoted is that by Bergeron. Two basic air masses are identified on thermal properties – polar (P) and

tropical (T), and two by moisture categories – maritime (m) and continental (c). The temperature of the air mass relative to the surface over which it is passing is included as warm (w) or cold (k) to give a wide range of combinations – mPw, cTk, etc. Willett modified this system slightly to add stable (s) or unstable (u) to indicate the likelihood of precipitation in the system. Other classifications distinguish equatorial, monsoon, and Arctic (or Antarctic) but difficulties can arise in identification.

**air stream** A flow of air that is not necessarily homogeneous but has a distinctive origin. Air streams are therefore distinguished by their direction of approach rather than assuming any specific thermal or stability properties. The mid-latitude westerlies can be regarded as being a mixture of slightly baroclinic air streams bounded by sharp frontal zones.

**Airy's hypothesis of isostasy** George Bedell Airy proposed that in order for isostatic equilibrium to exist, mountain ranges must have roots proportional to their height, i.e. the highest mountains have the deepest roots. These roots are composed of sialic material and displace an equivalent volume of sima, thereby causing the gravity anomalies present near mountain chains.

**Aitken nucleus** See nucleus.

**Aitoff's equal-area projection** A cylindrical map projection of a hemisphere. The major axis, the Equator, is twice the length of the minor, central meridian, axis. The projection is bounded by an ellipse. The main characteristics of this projection are that it is an equal-area projection and landmasses near the center of the area covered are of quite good shape, although the distortion increases towards the east and west limits of the projection.

**alabaster** A fine-grained white, sometimes translucent, variety of GYPSUM, used for making ornaments.

**albedo** An index of reflection comprising the ratio of reflected radiation to the total incident radiation. Usually this value is expressed in a percentage form for visible wavelengths. Typical values for surface albedo are: forest 5–10%, wet soil 10%, sand 20–30%, grass 25%, old snow 55%, concrete 17–27%, fresh snow 80%. Water surfaces vary from about 5% with high sun and calm seas to 70% at low elevation and rough seas. The planetary albedo of the Earth measured from artificial satellites is approximately 34%, which means that over one third of the Sun's radiation is returned to space without a change of wavelength.

**albite** A sodic plagioclase FELDSPAR.

**Alutian Low** The mean low pressure center in the N Pacific Ocean. It represents a statistical average of pressure value and location, which in turn are determined by the tracks of the depressions and the point at which they reach their lowest pressure. It is most marked in the winter.

**alexandrite** A transparent emerald-green type of CHRYSOBERYL, used as a semi-precious gemstone. It has the unusual property of turning red in artificial light.

**alfisol** One of the ten soil orders of the SEVENTH APPROXIMATION, covering pedalfers that are equivalent to the gray-brown podzolic, gray-wooded, gray-forest, sol lessivé, degraded chernozem, and planosol soils of the old American classification. They are found in the humid regions of the world under deciduous woodland or grassland vegetation. The dominant soil-forming process is leaching, which is more intense in these soils than in the inceptisols but less than in the spodosols. They are productive soils and favor the more common agricultural crops.

**algae** A group of largely aquatic organisms formerly classified as plants. It includes both microscopic forms, such as the DIATOMS, as well as the multicellular seaweeds, which may grow to a large size. Algae are subdivided into different phyla

that are now usually placed in the kingdom Protista (or Protoctista). The only geologically significant algae are those having hard parts, which may form bioherms, either by trapping sediment or by secreting massive laminated structures of calcium carbonate. Such structures commonly constitute lower Paleozoic REEFS. Compared with bacteria and fungi, algae are relatively unimportant in soils, but they are often pioneers in colonizing new ground and may number as many as 100 000 per gram of dry surface soil.

**algal bloom** A sudden increase in the numbers of ALGAE in a lake or river, caused by an increase in the amount of nitrates, phosphates, and other nutrients. *See* eutrophication.

**alidade** A surveying instrument used for sighting onto objects of detail and for defining the rays to be drawn to them in PLANE TABLING. The alidade is basically a ruler of metal or wood with a vertical slit sight at the observer's end and a vertical stretched wire sight at the other. (A telescope is fixed parallel to the ruler in more sophisticated types of alidade.) The ruler edge is placed against the point marked on the table over which the apparatus is standing, and detail to be fixed is sighted onto. A ray is then drawn on the plane table sheet along the ruler edge. Although either side of the ruler may be used initially, once one ray has been drawn, only that side may be used until that sheet is completed.

**alkali** (alkaline) (in petrology and mineralogy) Denoting igneous rocks and minerals that have high contents of the alkali metal oxides,  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ . For a given silica content such rocks are relatively richer in sodium and potassium and poorer in calcium compared with calc-alkaline rocks. *See* alkali basalt; alkali gabbro; granite; ijolite; nephelinite.

**alkali basalt** A basic undersaturated volcanic rock that is the fine-grained equivalent of ALKALI GABBRO. The essential minerals of all basalts are plagioclase feldspar of labradorite-bytownite composi-



tion and pyroxene. In alkali basalts the pyroxene is augite or titanaugite and olivine is present in abundance. Olivine is frequently rimmed or pseudomorphed by the alteration products iddingsite and/or serpentine. Small amounts of alkali feldspar and/or feldspathoid (nepheline or analcite) may be present. Alkali basalts are typically porphyritic. Basalts containing large plagioclase phenocrysts are referred to as *feldsparphyric* or *big feldspar* basalts. Those rich in olivine and augite are termed picrite basalts. Oceanite and ankaramite are varieties in which olivine and augite respectively have become concentrated.

Alkali basalts are usually holocrystalline and have ophitic or intergranular textures. Nodules of gabbro and peridotite are often found in alkali basalt lavas. With an increase in the amount of nepheline to greater than 10%, alkali basalts pass into basanites (olivine-bearing) and tephrites (olivine-free). In some rocks, the place of nepheline is taken by analcite or leucite and such terms as analcite-basanite and leucite-tephrite are appropriate. *See also* basalt.

**alkali feldspar** A member of a series of minerals with composition varying between the two end-members albite ( $\text{NaAlSi}_3\text{O}_8$ ) and orthoclase ( $\text{KAlSi}_3\text{O}_8$ ). *See* feldspar.

**alkali gabbro** Alkali gabbros and syenogabbros are basic plutonic rocks containing, in addition to the normal gabbro mineralogy, alkali feldspar and/or feldspathoids. Syenogabbros contain approximately equal amounts of alkali and plagioclase feldspar with TITANAUGITE, ANALCIME, and/or NEPHELINE plus or minus olivine. Having more sodium and potassium than gabbros, syenogabbros are, as the name implies, related to SYENITES.

*Essexite* consists of labradorite, titanaugite, and olivine together with small amounts of nepheline and/or analcime. Alkali feldspar, apatite, and ilmenite may also be present. *Teschenite* and *crinanite* are analcime-bearing varieties from which nepheline is excluded. *Theralite* is a nepheline-bearing gabbro containing no analcime. *Kentallenite* is a saturated rock

containing augite, olivine, biotite, labradorite, and orthoclase and is equivalent to olivine-monzonite.

The names of the plutonic rocks are applied to the medium-grained varieties of doleritic aspect but with the prefix 'micro-'. The volcanic equivalents include basanites, tephrites, and trachybasalts. *Teschenite* and *theralite* are found in differentiated sills and dikes.

**alkaline soil** *See* acid soil.

**allanite** (orthite) One of the EPIDOTE group of minerals.

**Alleröd** A phase of warming of about 1000 years during the period of deglaciation after the Würm/Weichsel/Wisconsin ice age. In many parts of NW Europe this was followed by a sudden cooling from 8800 to 8300 BC. The type-site from which the period takes its name is in Denmark.

**allivalite** A gabbro consisting of olivine and plagioclase feldspar of bytownite-anorthite composition.

**allochem** A discrete calcareous particle that has usually been transported at some stage, including FOSSILS, ooliths (*see* oolite), INTRACLASTS, and PELLETS, found in LIMESTONES; the terminology used in the petrographic description and classification of limestones is based upon these constituents and the matrix in which they are set (*see* micrite; sparite). Thus a limestone composed of fossil fragments set in a micrite matrix is a biomicrite; a pellet limestone with a sparite matrix is a pelisparite.

**allochthonous** Denoting an isolated mass of rock displaced over a considerable distance from its original source by low-angle thrusting. *Compare* autochthonous.

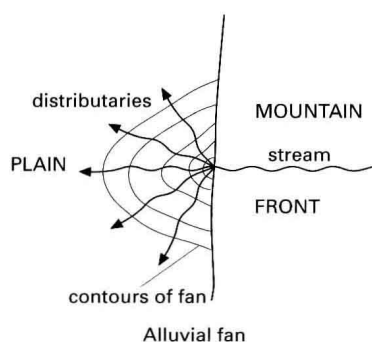
**allogenic** (allothigenous) Describing rock constituents that were formed at some distance from their present location, particularly minerals or rock fragments derived from existing rocks. *Compare* authigenic.



**allotriomorphic** Describing a rock in which the majority of crystals are euhedral. *Compare* hypidiomorphic; idiomorphic.

**allotrope** A form of a chemical element that differs (usually in its crystal structure) from another form of the element. Graphite, diamond, and buckminsterfullerene, for example, are allotropic forms of carbon.

**alluvial cone** A steep alluvial deposit that forms where a fast-flowing stream debouches onto a lowland plain. Apart from its steepness, it in other respects resembles an ALLUVIAL FAN.



**alluvial fan** A fan of material deposited by a stream where it debouches from a mountain front onto a plain, with the apex of the fan at the point of emergence from the mountains. In its mountain tract, the stream will have been confined into a single flow in a rock-cut gorge, but on reaching the plain this control is lost, and it breaks up into a number of distributaries. This increases the wetted perimeter, or area of contact between water and land, and hence friction increases; with more of its energy used in overcoming friction, less is available for sediment transport, so deposition occurs, in the form of a fan. This is the direct landborne analogy to DELTA formation, and alluvial fans are characteristic landforms of arid and semiarid environments.

**alluvium** The products of SEDIMENTATION by rivers, sometimes including deposits in estuaries, lakes, and other bodies of fresh water. Alluvium includes material of a wide range of PARTICLE SIZES, usually restricted to the silt size fraction of 0.006–0.02 mm

There is a marked decrease in the size of alluvial material down-valley, with finer material in the lower reaches. This may be due to SORTING, which leaves coarse material behind and carries finer material down-valley, or it may be due to progressive wear of the material as it travels downstream. Another cause may be that smaller valley-side slopes downstream supply a finer caliber of material to the stream.

Within the FLOODPLAIN, alluvium (in the looser sense) varies in size from the finest clay and silt-sized material through sands to coarse angular gravels. The gravels form the basal portions of alluvial valleys, and may have originated at the end of the PLEISTOCENE period under PERIGLACIAL conditions; in some rivers they are attributed to deposition within the channel in conditions in which severe scour removed the fine material. Silts, sands, and gravels are more important, constituting 75% of the Mississippi alluvium. Sands constitute the point bars formed on the inside of meander bends, and are an important constituent of levées. Silts and clays are deposited in the lee of point bars or as overbank deposits in times of flood, covering the far reaches of the floodplains with backswamp deposits.

**almandine** A light red to red-brown member of the GARNET group of minerals,  $\text{Fe}_3\text{Al}_2(\text{SiO}_4)_3$ . Deep red crystals are valued as semiprecious gemstones.

**alnoite** A basic or ultrabasic dike rock composed largely of melilite and biotite with subordinate pyroxene, calcite, and olivine. Alnoite is found in ijolite-carbonatite complexes.

**alp** A region of grassland on a high mountainside. Above the timberline and covered with snow in the winter, alpine grassland may be used as pasture for graz-