Glossary of Geology

Fifth Edition

Neuendorf
Mehl
Jackson

AMERICAN GEOLOGICAL INSTITUTE

Fifth Edition

GLOSSARY OF GEOLOGY

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Artwork at alphabet section openings courtesy of the U.S. Geological Survey: **A.** Asbestos, Gila County, Arizona; highly magnified, scanning electron microscope view of one of the three common types of commercially mined asbestos (U.S. Geological Survey, 1980). **B.** Boudinage, Rio Extorax, Queretaro, Mexico (K. Segerstrom, 1956). **C.** Columnar basalt, San Miguel Regla, Hidalgo, Mexico ©. Fries). **D.** Dike, Mount Clark, Lincoln County, Maine; pegmatite vein in diorite (T. N. Dale). **E.** Earthquake, Anchorage, Alaska, Cook Inlet region; collapse of 4th Avenue district near C Street, due to a landslide caused by the earthquake (1964). **F.** Fault, Minas Gerais, Brazil; steep reverse fault in dolomitic marble ®. M. Wallace, 1957). **G.** Gneiss, Gunnison area, Colorado; contorted gneiss, north rim of the Black Canyon near Colorado State Highway 92 (W. R. Hansen). **H.** Hogback, Niobrara Limestone, El Paso County, Colorado—west of Colorado Springs (N. H. Darton, 1926). **I.** Iceberg, Sohlstenholme Fjord, northeast of Thule Air Base, Nunatarssnaq region, Greenland ®. B. Colton, 1953). **J.** Joints, Las Animas canyon, San Juan County, Colorado; joints in granite cut by veins of quartz, feldspar, and biotite ©. W. Cross, 1900). **K.** Karst topography, along Li River, China (W. H. Monroe, 1983). **L.** Leaves, Metasequoia occidentalis (Newberry), Chaney, Stevens County, Washington; fossils from tuffaceous sandstones of the gerome andesite, Northwest Uranium Mine (G. E. Becraft, 1957). **M.** Moraines, Eastern Chugach Mountains, Chitina district, Copper River region, Alaska; view of Ross Green Lake and moraines (E. E. Brabb, 1959). **N.** Nunatak encircled by moraine, Alaska Gulf region, Alaska (D. J. Miller, 1958). **O.** Oxbow lake, Yukon region, Alaska; oblique aerial view of an oxbow lake and meanders of Hodzana River (J. R. Williams, 1948). **P.** Pahoehoe, Hawaii Volcanoes National Park, Hawaii; near view of ropy crust of pahoehoe lava on crater floor, Kilauea Volcano (H.R. Joesting, 1950). **Q.** Quartzite, Riverside Mountains, Riverside County, California; isoclinally folded quartzite (W.B. Hamilton, 1967). **R.** Rockfall, El Rancho rockfall on Interstate 70, Jefferson, County, Colorado (W.R. Hansen, 1973). **S.** Stalactites, Carlsbad Caverns National Park, Eddy County, New Mexico; pendulum stalactites in the "Rookery" (W.T. Lee, 1923). **T.** Till, Yosemite National Park, Mariposa County, California; glacial till, an unsorted mixture of boulders, sand, and clay exposed along Tioga Road at Siesta Lake (N.K. Huber). **U.** Unconformity, San Lorenzo Arroyo, Arizona (R.H. Chapman). **V.** V-shaped valley, Grand Canyon of the Yellowstone, Yellowstone National Park, Wyoming (W.T.Lee, 1921). **W.** Wind erosion, Illano de Caldera, Atacama Province, Chile; granite outcrop that has been etched and pitted by the abrasive action of windblown sand (K. Segerstrom). **X.** Xenolith, Moerakai, New Zealand; schist xenoliths (white) in layered gabbro (W.B. Hamilton, 1965). **Y.** Yosemite Valley from vicinity of Artist Point, Yosemite National Park, California (F.E. Matthes, 1923). **Z.** Zircon, Eureka County, Nevada; scanning electron microscope micrograph shows detrital zircon crystal in a matrix of porous authigenic clay minerals from Carlin Gold Mine (A.K. Armstrong, 1984).

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Preface—Fifth Edition

The revising and updating of earth science terminology and of the concepts behind and communicated through it—these are continuous processes for which this fifth edition of the AGI *Glossary of Geology* provides just another frozen moment of panoramic overview. Naturally, the number of terms, definitions, and acronyms has increased again over the previous edition—from the previous more than 37,200 to this edition's nearly 39,300 entries. The main purpose of the *Glossary* is to assist readers and writers of contemporary earth science; yet antiquated and obsolete terms have been removed only sparingly.

Through the generous assistance of the Mineralogical Society of America and the late Dr. Richard A. Bideaux, mineral formulas from the *Handbook of Mineralogy* (Anthony et al., 1990-2003) are included in this edition of the Glossary. The formulas are expressed in a way that conveys information about a mineral's crystal chemistry and structure as well as its composition. The number of mineral names has been increased by about 1,000, to a new total of more than 5,300. As in the previous edition, for more information about mineral species, *Glossary* users are referred to the *Mineral Reference Manual* by Nickel and Nichols (1991).

The authority of this *Glossary* rests on the expertise of more than a hundred eminent geoscientists who participated as volunteers in the arduous task of a two-level review and whose names are listed in the "Acknowledgments" on pages xi and xii. Their contributions have been incorporated, as far as possible, in each reviewer's individual manner, so that some variance of form will be seen between different entries.

In view of the constant changes in terminology, we invite all our users to suggest additions and corrections for future versions of the *Glossary*. Such suggestions may be sent to the American Geological Institute or to <glossary@agiweb.org>.

Even this fifth edition of the *Glossary* owes much to Julia A. Jackson who, as collaborator with Robert L. Bates on the second and third editions and as sole editor of the fourth edition, has guided the progress of the *Glossary* most capably and with deep dedication through a quarter of a century. She has provided much of the impetus and the groundwork for the present edition. I feel honored by her participation and grateful for her contributions.

Jim Mehl deserves particular credit for coordinating the many divergent portions of the publication project at the AGI headquarters and for overseeing the updating of the database for the printed *Glossary*.

August 2005 Klaus K.E. Neuendorf

Preface—Fourth Edition

The practice, technology, and terminology of the earth sciences have changed a lot in the 10 years, since the American Geological Institute published the third edition of the *Glossary of Geology*. Geoscientists use geographic information systems (GIS) and global positioning systems (GPS) as well as new tools and techniques for analysis, modeling, exploration, and communication. This fourth edition reflects both advances in scientific thought and changes in usage. Approximately 3,400 of the 37,000-plus entries are new and nearly 9,000 definitions have been updated. Although the *Glossary* has retained many obsolete terms for their historical value, more than 3,000 terms that have rarely been used have been dropped.

The *Glossary* has expanded coverage particularly in such active fields as carbonate sedimentology, environmental geology and geophysics, GIS, GPS, hydrology and hydraulics, marine and coastal geology, organic geochemistry, paleoecology, seismology, sequence stratigraphy, speleology and karst, and structural geology and tectonics. More than 10 per cent of the terms in the *Glossary* are from paleontology, and more than 100 conodont morphology terms have been added. Stratigraphic terms and definitions have been updated in accordance with the *International Stratigraphic Guide* (1994). Igneous rock terms have been updated following the classification of igneous rocks established by the International Union of Geological Sciences Subcommission on the Systematics of Igneous Rocks (Le Maitre et al., 1973; Woolley et al., 1996).

The 4,000-plus mineral names in the *Glossary* constitute its largest single group of terms, Since 1987, so much has been learned through the analysis of crystal structure that many of the mineral definitions required updating. Revised formulas are expressed in a form to emphasize crystal chemistry and structure. The fundamental building block of a mineral— the region of most highly charged (highest bond valence) units— is given within brackets. This fundamental building block along with the hydrogen bonding tells much about a mineral's properties. In expressing the structural formula of a mineral, hydroxyls and water ligands follow their bonded cations parenthetically; hydrate water follows at the end after a centered dot. Because hydrogen bonding occurs in at least half of the mineral species, the role of the hydrogen atom is extremely important in interpreting crystal structure and mineral paragenesis. The chemical formula for laueite, a mineral named in honor of Max von Laue, one of the co-discoverers of X-ray diffraction by crystals, illustrates the many roles of hydrogen played out in the crystal structure:

Laueite: $Mn^{2+}(H_2O)_4[Fe^{3+}(H_2O)(OH)(PO_4)]2.2H_2O$

Expressing formulas for minerals which are organic molecules or salts of organic acids or bases can be problematic. About 20 natural oxalates are known, and the oxalic acid radical is commonly presented as (C_2O_4). The oxalic acid radical appears int eh *Glossary* as $(OOC\text{-}COO)^{2-}$ to reflect the bonding and to avoid confusion. Glossary users seeking more information about mineral species are referred to the *Mineral Reference Manual* (1991) by Nickel and Nichols.

To produce this edition, the American Geological Institute invited eminent geoscientists to review and update sets of terms and definitions from the third edition by discipline. They also proposed terms and definitions to be added. As with earlier editions the accuracy and authority of the *Glossary of Geology* result from the scholarship and expertise of the reviewers. Nearly 120 experts worked on this revision, and their names appear on pages xi-xii. It speaks well for the earth sciences that so many outstanding geoscientists willingly make time as volunteers to work on each new edition. They, like former *Glossary* editor Robert L. Bates, science editors of the second and third editions. His meticulous editorial work, insistence on clarity, and breadth of

knowledge set the *Glossary's* standard for quality. Bob and I began planning for this edition in 1994— just a few months before his death. He made a significant contribution by classifying terms *Glossary* users had submitted since 1987 and by reviewing lists of potential new terms generated by searching AGI's GeoRef database. Bob's philosophy and work permeate the *Glossary of Geology*, and I think he would approve of the fourth edition. It meets his standard for quality thanks to the unstinting help from reviewers, constructive criticism from users, and active support of the revision by AGI management and staff.

April 1997 Julia A. Jackson

Preface—Third Edition

As earth scientists continue to generate new facts, concepts, and interpretations, the geological language necessarily expands and evolves. This third edition of the *Glossary of Geology* incorporates more than 1,000 new terms and definitions, and expands or brings up to date some 650 definitions from the previous edition. In addition, it includes for the first time the division of terms into syllables, with accents to aid in pronunciation. Approximately 150 references have been added to the 2,000 in the second edition.

New entries are especially numerous in the fields of carbonate sedimentology, hydrogeology, marine geology, mineralogy, ore deposits, plate tectonics, and snow and ice. Terms and definitions recommended in the North American Stratigraphic Code (1983) are included.

The authority of this edition, like that of its predecessor, rests on the expertise of geoscientists from many specialties. their contributions make the *Glossary* an essential reference work for all in the geoscience community.

April 1987 Julia A. Jackson
Robert L. Bates

Preface—Second Edition

"If it were not for the occasional appearance of an authoritative glossary," wrote Ian Campbell in his preface to the first edition of this work, "our language. . . would rapidly degenerate into babel." He added that as the science advances and knowledge expands, we modify and improve our concepts, and with this must come modification and enlargement of our vocabulary.

The American Geological Institute had recognized the need for a glossary, and in 1957, in cooperation with the National Academy of Sciences, it published a 14,000-term supplement, appeared in 1960. These gave rise, in 1972, to AGI's one-volume *Glossary of Geology*, containing nearly 33,000 terms.

The present volume, the 36,000-term second edition, incorporates the modifications and growth of the geoscience vocabulary since 1972. Coverage has been expanded and updated, particularly in such active fields as biostratigraphy, caves and karst, igneous petrology, paleomagnetism, remote sensing, plate tectonics, and seismic stratigraphy.

Some 450 new mineral names join the 4,000 in the previous edition; more than 100 abbreviations commonly used by geoscientists make their first appearance; and the list of references includes about 400 additional entries.

We acknowledge the pioneering work of J.V. Howell, who set the course and standards of excellence for the *Glossary of Geology and Related Sciences*, and the editorial advice and counsel of Frank C. Calkins, who helped materially in the preparation of the first edition of the *Glossary of Geology*.

We hope this *Glossary* will meet the needs of the geoscience community, and will prove to be a bulwark against the babelisation of the geological language.

December 1979

Julia A. Jackson
Robert L. Bates

Introduction

All terms listed in this *Glossary* have appeared in English-language publications or other writings in English and generally reflect North-American usage, unless otherwise noted. Many obsolete terms have been retained, as they remain valuable to readers using the older literature. Besides giving the current or preferred meaning of a term, some definitions include information on original usage or historical development.

Alphabetization generally follows a letter-by-letter system, ignoring spaces or nonalphabet characters. Thus, e.g., *A horizon* is listed between *ahlfeldite* and *Ahren's prism*. Numbers are listed before letters.

Syllabication is usually given in parentheses following the first appearance of a term. As an aid to pronunciation, a stress mark (') is inserted following the primary stressed syllable; in some cases, primary and secondary stresses are differentiated by heavy (') and light (') stress marks. In exceptional cases, pronunciation is suggested by "Pron: . . ."—usually in brackets within the syllabication parentheses.

Italicized words refer the reader to related terms or definitions that can be found elsewhere in the *Glossary*, except in cases where italics are used for Latin species names. This practice extends to some variants, such as plurals of listed terms.

Citations to the literature are given in many definitions, mainly as examples of usage. The works referred to are listed in the section "References Cited" at the end of the *Glossary*.

Multiple definitions for a term are separated by (a), (b), (c), and so on.

Bracketed identifiers are added to terms that have meanings in more than subject area. They are treated as separate entries. Such identifiers are either spelled out or abbreviated according to the following list of abbreviations:

arch—archaeology
astron—astronomy
biol—biology
bot—botany
cart—cartography
chem—chemistry
clim—climatology
cryst—crystallography
drill—drilling
eco geol—economic geology
env geol—environmental geology
evol—evolution
exp petrol—experimental petrology
exp struc geol—experimental structural geology
geochem—geochemistry
geochron—geochronology
geog—geography
geol—geology
geomorph—geomorphology
geophys—geophysics
glac geol—glacial geology
glaciol—glaciology
grd wat—ground water
hist—history and philosophy of geology
hydraul—hydraulics
hydrogr—hydrography
hydrol—hydrology
ign—igneous
intrus rocks—intrusive rocks
magnet—magnetism
marine geol—marine geology
mass move—mass movements
math—mathematics
meta—metamorphism
metal—metallurgy
meteorol—meteorology
mineral—mineralogy
oceanog—oceanography
ore dep—ore deposits
paleont—paleontology
palyn—playnology
part size—particle size
pat grd—patterned ground
philos—philosophy
photo—photography
phylogen—phylogenetics
phys—physics
planet—planetology
pyroclast—pyroclastics
rock mech—rock mechanics
sed—sedimentology
sed struc—sedimentary structures
seis—seismology
speleo—speleology
stat—statistics
stratig—stratigraphy
struc geol—structural geology
struc petrol—structural petrology
surv—surveying
taxon—taxonomy
tect—tectonics
topog—topography
volc—volcanism
weath—weathering

Abbreviations of certain common terms are used in the definitions (generally without regard to upper- or lower-case spelling) as follows:

abbrev:—abbreviation/abbreviated
adj:—adjective
ant:—antonym
cf:—compare/see also (Latin: "confer")
CGS (-System)—Centimeter-Gram-Second System
cgs (unit)—centimeter-gram-second unit(s)
e.g.—for example (Latin: "exempli gratia")
esp.—especially
et al.—and others (Latin: "et alii")
etc.—and so forth (Latin: "et cetera")
etymol: etymology
i.e.—that is (Latin: "id est")
n.—noun
pl:—plural
pron:—pronounced
q.v.—which see (Latin: "quod vide")
SI—International System of Units (French: "Système International d'Unités")
sing:—singular
specif.—specific(ally)
syn:—synonym(s)
v.—verb
var.—variant

Acknowledgments

Specialists in many fields of geoscience have volunteered their help in bringing the widely used fourth edition of the *Glossary* up to date, by reviewing definitions, adding new terms, recommending corrections, and citing references. The geoscience community owes special gratitude to the following persons for taking the responsibility of acting as group leaders and reviewing and editing fields with many subcategories and reviewers or those fields with massive amounts of data: Gail M. Ashley, Wolfgang H. Berger, Arthur L. Bloom, Robert W. Kay, Patricia H. Kelley, Ernest H. Nickel, Amos Salvador, Roy W. Schlische, Robert E. Sheriff, Al Traverse.

The fields covered in the *Glossary* that have been reviewed for the fifth edition, with their reviewers, are given below.

Archaeology George R. Rapp, Jr.

Astrogeology Richard A. F. Grieve, Ralph P. Harvey, James R. Zimbelman

Cartography/surveying/map projections John B. Conroy, Michael P. Finn, Jane A. Messenger, John P. Murphey, Leland A. Perry, Robert E. Rinehart

Climatology Reid Bryson, Edward J. Hopkins, Joseph M. Moran

Coal geology James C. Hower, Maria Mastalerz, John Popp

Economic geology Mark D. Barton, Keith R. Long

Energy sources Edward A. Beaumont, J. B. Thomas

Engineering geology Jeffrey R. Keaton, Roy J. Shlemon, Jim Slosson,

Environmental geology Alan Kehew, Edward A. Keller

Extraterrestrial Geology Al Harris, Kenneth L. Tanaka, John T. Wasson, John A. Wood

Forensic geology Sarah Andrews

General geology William R. Brice, James H. Shea

Geochronology Fred W. McDowell, Amos Salvador

Geomorphology/surficial geology Arthur L. Bloom, , Don J. Easterbrook, William L. Graf, Joseph Kelley, Daniel A. Livingstone, Henry J. Melosh, John Mylroie, Arthur N. Palmer, Jonathan D. Phillips, William Renwick, Ellen E. Wohl,

Geophysics, applied Serguei A. Goussev, Larry D. Lines, L. J. Patrick Muffler, Daniel R. Roman, Robert E. Sheriff, George A. Thompson, Ralph R. B. von Frese

Geophysics, general Alex Becker, Serguei A. Goussev, Robert E. Sheriff

Geophysics, solid earth Gunter Faure, John W. Geissman, Willian J. Hinze, Michael E. Wysession,

Geophysics, seismology Larry D. Lines, Robert E. Sheriff, Donald W. Steeples

History and philosophy Robert H. Dott, Jr., Sally Newcomb

Igneous petrology Susan M. DeBari, Marc J. Defant, Grant Heiken, Robert W. Kay, Wesley E. LeMasurier, Malcolm J. Rutherford, Gene Yogodzinski

Information systems/informatics G. Randy Keller

Marine geology/oceanography Daniel C. Abel, Wolfgang H. Berger, Alison Duxbury, Alyn Duxbury, Robert N. Ginsburg, Philip A. Meyers, Kenneth G. Miller, Robert H. Stewart

Metamorphic petrology Theodore Labotka

Mineralogy Carl A. Francis, Dana T. Griffin, Ernest H. Nickel, Caroline Nelms

Paleobotany/palynology David Dilcher, Lucy Edwards, Jan Jansonius, Edith Taylor, Al Traverse, Gordon Wood

Paleontology, general Loren Babcock, Rodney Feldmann, Roger L. Kaesler, Bruce S. Lieberman, Donald R. Prothero

Paleontology, morphology William I. Ausich, Joseph G. Carter, Pamela Hallock-Muller, Patricia H. Kelley, Jason A. Lillegraven

Quaternary geology Arthur L. Bloom, Roger Hooke, Joan M. Ramage

Remote sensing Jeffrey Moersch

Sedimentary petrology Gail M. Ashley, Henry S. Chafetz, Richard J. Cheel, Michael S. Fenster, Richard L. Hay, Charlotte Schreiber, Frederick L. Schwab, John Southard

Stratigraphy Amos Salvador, Mary L. Droser, Steven M. Holland, James G. Ogg

Structural geology Nancye Dawers, Terry Engelder, Eric A. Erslev, Steven Marshak, Gautam Mitra, Roy W. Schlische, Carol Simpson, Jan A. Tullis, Martha Withjack

To produce the fifth edition Inez Morgart and Gayatri Tetali made data corrections and lightened the load; Lawrence Berg refined the Glossary data base and wrote verification and print programs; Kay Yost and Karin Mills efficiently typeset and formatted the book; John Rasanen, Sharon Tahirkheli, and Marcus Milling provided resources within AGI that kept the revision on track.

GLOSSARY OF GEOLOGY—Fifth Edition

A

A *mass number.*

aa (a'-a [ah'-ah]) A Hawaiian term for lava flows typified by a rough, jagged, spinose, clinkery surface. Cf: *pahoehoe; block lava.* Etymol: Hawaiian. An expletive of pain when walking barefoot on such lava. Obs. syn: *aphrolith.*

Aalenian (Aa-le'-ni-an) A stage of the Standard Global Chronostratigraphic Scale: lowermost Middle Jurassic (above Toarcian, below Bajocian). The basal GSSP is at Fuentelsalz in central Spain (Cresta et al., 2001).

AAR *accumulation-area ratio.*

AAS *atomic absorption spectroscopy.*

a* axis That axis of a reciprocal crystal lattice which is perpendicular to (100). Cf: *b* axis; c* axis.*

***a* axis [cryst]** One of the crystallographic axes used as reference in crystal description. It is the axis that is oriented horizontally, front-to-back. In an orthorhombic or triclinic crystal, it is usually the *brachy-axis.* In monoclinic crystals, it is the *clinoaxis.* The letter *a* usually appears in italics. Cf: *b axis [cryst]; c axis [cryst].*

***a*-axis [ice]** In a hexagonal crystal are three *a*-axes. They are perpendicular to the c-axis and make angles of 60° to one another. Cf: *c-axis [ice].*

***a* axis [struc petrol]** One of three orthogonal reference axes, *a, b,* and *c,* that are used in two distinct ways. (a) To help describe the geometry of a fabric possessing orthorhombic or monoclinic symmetry. The unique symmetry plane is labelled the *a-c* plane, and *a* lies at the intersection of this plane with a prominent fabric surface. (b) In a kinematic sense, to describe a *deformation plan* that possesses orthorhombic or monoclinic symmetry, such as progressive pure or simple shear. In this case the *a* axis again lies in the unique plane of symmetry but parallel to the movement plane. It is the direction of maximum displacement and is commonly referred to as the direction of tectonic transport. In a progressive simple shear the *a* axis is the direction of shear. See also: *b axis [struc petrol]; c axis [struc petrol].* Syn: *a direction.*

abactinal (ab-ac'-ti-nal) A syn. of *aboral.* Ant: *actinal.*

abandoned channel (a-ban'-doned) (a) A drainage channel along which runoff no longer occurs, as on an alluvial fan. (b) *oxbow.*

abandoned cliff A sea cliff that is no longer undergoing wave attack, as a result of a relative drop of sea level or progradation at the cliff base.

abandoned meander *cutoff meander.*

abapertural (ab-ap-er'-tur-al) Away from the *aperture* of a gastropod, nautiloid, or tentaculite shell. Ant: *adapertural.*

abapical (ab-ap'-i-cal) Away from the *apex* of a gastropod shell and toward the base, along the axis of spiral or slightly oblique to it.

abathochroal eye (ab-ath'-o-chro'-al) A trilobite eye superficially similar to a *schizochroal eye* but possessing no scleral projections.

abaxial (ab-ax'-i-al) Directed or facing away from, or situated on the outside of, the axis or center of the axis, as of an organ, plant, or invertebrate; *dorsal* or *anterior.* Also, said of the abaxial side. Ant: *adaxial.*

Abbe refractometer An instrument used for determining the refractive index of liquids, minerals, and gemstones. Its operation is based on measurement of the *critical angle.*

abbreviation (ab-bre'-vi-a'-tion) Loss of the final ontogenetic stages during the course of evolution.

ABC method A seismic refraction method, often used for correcting seismic data for the effect of irregular thickness of the surficial *low-velocity layer* (Sheriff and Geldart, 1995, p.433).

ABC soil A soil with a distinctly developed profile, including A, B, and C horizons.

abdomen (ab'-do-men) (a) The posterior and often elongated region of the body of an arthropod, behind the *thorax* or *cephalothorax;* e g. the *tagma* following the thorax of a crustacean, including the *telson,* and consisting of seven or fewer segments; or the complete, usually unsegmented part of the body of an arachnid or merostome, following the cephalothorax. Cf: *opisthosoma; pygidium.* (b) The third joint of the shell of a nasselline radiolarian. Pl: abdomens or abdomina. Adj: abdominal.

abelsonite (a'-bel-son-ite') A semi-metallic purple triclinic mineral: $C_{31}H_{32}N_4Ni$ (nickel porphyrin).

abenakiite-(Ce) A pale brown rhombohedral mineral: $Na_{26}(Ce,Nd,La)_6(SiO_3)_6(PO_4)_6(CO_3)_6(SO_2)O$.

aber The mouth of a river, or the confluence of two rivers. Etymol: Celtic.

abernathyite (ab-er-nath'-y-ite) A yellow tetragonal mineral: $K(UO_2)(AsO_4)\cdot 3H_2O$.

aberration (ab-er-ra'-tion) Any disturbance of the rays of a beam of light such that they cannot be brought to a sharp focus or form a clear image.

abhurite (ab-hur'-ite) A colorless rhombohedral mineral: $Sn^{2+}{}_{21}O_6Cl_{16}(OH)_{14}$.

abime (a) Abyss. (b) Wide, deep shaft in limestone, the walls of which are vertical or overhanging. Etymol: French "abîme", "chasm".

AB interray Right anterior interray in echinoderms situated between A ray and B ray and clockwise of A ray when the echinoderm is viewed from the *adoral* side; equal to interambulacrum 3 of the *Lovenian system.*

abiogenesis (a-bi'-o-gen'-e-sis) The development of living organisms from lifeless matter. Cf: *biogenesis.*

ablation [geomorph] (ab-la'-tion) Separation and removal of rock material, and formation of residual deposits, esp. by wind action or the washing away of loose and soluble materials. Most writers prefer to restrict the term to wasting of glaciers by melting and evaporation.

ablation [glaciol] (a) All processes by which snow and ice are lost from a glacier, from floating ice, or from a snow cover. These processes include melting, evaporation (sublimation), wind erosion, and calving. Sometimes ablation is restricted to surface phenomena, thus excluding *calving.* Cf: *accumulation.* (b) The amount of snow or ice removed by the process of ablation. Syn: *wastage [glaciol].*

ablation [meteorite] Removal of surface layers of meteorites and tektites resulting from the impacts of air molecules during flight through the atmosphere.

ablation area The part of a glacier or snowfield in which, over a year's time, ablation exceeds accumulation; the region below the *equilibrium line.* Cf: *accumulation area.* Syn: *zone of ablation.*

ablation breccia *solution breccia.*

ablation cave A type of *glacier cave,* a few meters in height and width, formed near a glacier terminus by circulating warm air, generally where a meltwater stream flows from beneath the ice.

ablation debris Rock material of all sizes, from blocks to clay, as isolated fragments or discontinuous piles on the glacier surface; not continuous enough to form *ablation moraine.* The term is also used for that material comprising ablation moraine.

ablation form A feature formed on a surface of snow, firn, or ice by melting or evaporation; e.g. *nieve penitente* or *ice pyramid.* Rarely used.

ablation funnel A closed depression, similar to a solution channel, formed by solution processes or by removal of particulate material by circulating groundwater.

ablation gradient A term apparently first introduced by Haefeli (1962) to refer to the variation in specific *net balance* with altitude up to the *equilibrium line* of a glacier, but redefined by Schytt (1967) as the change in specific *summer balance* with altitude over the entire glacier. It is usually expressed as millimeters of water equivalent per meter of altitude. Cf: *budget gradient.*

ablation moraine An uneven pile or continuous layer of *ablation till* or *ablation debris,* either overlying ice in the ablation area or resting on ground moraine derived from the same glacier.

ablation rate The amount of ice or snow loss per unit time from a glacier, from floating ice, or from snow cover. Usually expressed in millimeters of water equivalent per hour or day or year.

ablation season In glaciology, that period of a year when the *balance* of a glacier decreases from a maximum value to a minimum value for the year. This is a period when, on the average, ablation exceeds accumulation. Syn: *summer season.*

ablation spherule Glassy, spherical to semi-spherical particles produced by the erosional removal of melt droplets from the exterior of meteorites during passage through Earth's atmosphere. See: *cosmic spherule; meteoritic dust.*

ablation till Loosely consolidated rock debris, formerly in or on a glacier, that accumulated in place as the surface ice was removed by ablation.

ablatograph (ab-lat'-o-graph) An instrument that measures the loss of snow, firn, or ice from a surface by ablation during a given period.

ablykite (ab'-lyk-ite) A clay-mineral material consisting of an aluminosilicate of magnesium, calcium, and potassium. It resembles halloysite in its dehydration characteristics but differs from it in its thermal and X-ray diffraction properties. Also spelled: ablikite.

Abney level A rectangular telescope tube to one side of which is fastened a vertical, graduated arc with vernier and carrying a rotatable level. The instrument is small and light enough to be held in the hand. When used as a leveling instrument, the vernier is set at zero on the graduated arc. When used to determine vertical angles, the object is sighted through the tube and the vernier rotated until the bubble is centered in the vial. The angle is then read off the graduated arc. Named after William de Wiveleslie Abney (1843-1920), English physicist.

abnormal (ab-nor'-mal) Said of an anticlinorium in which the axial surfaces of the subsidiary folds converge upwards; said of a synclinorium in which the axial surfaces of the subsidiary folds converge downwards. Rarely used. Cf: *normal [struc geol].*

abnormal pore pressure Fluid pressure in the earth's crust that deviates substantially from hydrostatic pressure.

abnormal subaerial exposure In sequence stratigraphy, a type of basinward shift in facies marked by subaerial exposure of subtidal facies.

abnormal vertical association of facies *basinward shift in facies.*

aboral (ab-o'-ral) (a) Located opposite to or directed away from the mouth of an invertebrate; esp. applied to the surface (or to the structures on it) opposite that bearing the mouth and proximal ends of the ambulacral grooves of an echinoderm; or to the part of an echinoderm *theca* or plate directed away from the mouth (directed downward in an edrioasteroid). Cf: *adoral.* (b) Toward the underside of a conodont element; e.g. "aboral edge", "aboral groove", or "aboral attachment scar". Ant: *oral.*

aboral cup The bowl- to cone-shaped part of a crinoid *calyx* including the three major plate circlets, radials, basals, and infrabasals (if present).

aboral margin The trace of the aboral side of a conodont element in lateral view. The term has also been used for the aboral side itself.

aboral pole (a) The end of a flask-shaped chitinozoan that includes the chamber of the body and the base. Cf: *oral pole.* (b) The point of intersection of the oral-aboral axis with the aboral surface of the theca of echinoderms; it marks the center of the aboral surface.

aboral side The underside of a conodont element, to which the basal plate is attached or onto which the basal cavity or attachment scar opens. Cf: *oral side.*

aboral surface Morphologically related unit of an edrioasteroid *theca* distal to the oral surface plates; commonly forms only part of the lower side of the individual.

aboriginal (ab-o-rig'-i-nal) Said of the original race, fauna, or flora of a particular area, as distinguished from later immigrant or imported forms. n. aborigine.

abraded snow Snow crystals that are rounded mechanically by interaction with other particles in the saltation layer.

abrasion [geomorph] The mechanical wearing, grinding, scraping, or rubbing away (or down) of rock surfaces by friction and impact, in which the solid rock particles transported by wind, ice, waves, running water, or gravity are the tools of abrasion. The term *corrasion* is essentially synonymous. Also, an abraded place or the effect of abrading, such as the abrasion left by glacial action. v. abrade. Cf: *attrition.*

abrasion [streams] The physical erosion caused by sediment in transport, grinding against and colliding with the channel boundaries and other sediment within the channel.

abrasion pH A term proposed by Stevens and Carron (1948) to designate the characteristic pH achieved by a suspension of a pulverized mineral in water, resulting from a complex of hydrolysis and dissolution reactions.

abrasion platform An extensive, gently seaward-sloping intertidal surface produced by long-continued wave erosion. Term introduced by D.W. Johnson (1916, p.444); see also Trenhaile (1987). Cf: *erosion platform; wave-cut platform; plain of marine erosion.*

abrasion shoreline *retrograding shoreline.*

abrasion tableland A broad, elevated region in which the outcrops of various rocks have been reduced to nearly the same level by denuding agents (Stamp, 1961, p.2).

abrasive [geomorph] (ab-ra'-sive) n. A rock fragment, mineral particle, or sand grain used by natural agents in abrading rock material or land surfaces. adj. Possessing the characteristics of a tool for grinding or mechanical wear.

abrasive [materials] Any natural or artificial substance suitable for grinding, polishing, cutting, or scouring. Natural abrasives include diamond, emery, garnet, silica sand, diatomite, and pumice; manufactured abrasives include esp. silicon carbide, fused alumina, and boron nitride.

abrolho A term used for a mushroom-shaped barrier reef spreading widely near the surface. Etymol: Portuguese, "thorn; pointed rock". "Abrolho Islands" are found off the coasts of northwestern Brazil and southwestern Australia.

abrupt climate change Changes of hemispheric average temperature of 1-5 degrees Celsius over a period of decades to a few centuries associated with changes in the ocean's circulation, especially the circulation in the North Atlantic.

abrupt twist hackle The en echelon cracks produced upon reinitiation of rupture if there has been a stress field rotation following the arrest of a parent crack (Younes and Engelder, 1999). These structures may also form in more isotropic rocks such as granite. Cf: *twist hackle; gradual twist hackle.*

absarokite (ab-sa'-ro-kite) A *trachyandesite*, composed of phenocrysts of olivine and clinopyroxene in a groundmass of labradorite with alkali feldspar rims, olivine, and some leucite. Absarokite grades into *shoshonite* with a decrease in the olivine content and with the presence of some dark-colored glass, and into *banakite* with a decrease in the olivine and augite. It was named by Iddings in 1895 from the Absaroka Range, Wyoming.

abscission (ab-scis'-sion) Separation of plant parts, e.g. of a leaf from a stem, usually by cell-wall dissolution along a certain layer (*abscission layer*).

abscission layer The zone of cells, e.g. at the base of a petiole, along which separation of plant parts occurs. Syn: *separation layer.*

absite A thorian variety of *brannerite.*

absolute abundance (ab'-so-lute) The exact number of individuals of a taxon in a certain area or volume. See also: *abundance [ecol]; relative abundance.*

absolute age *numerical age.* The term is now in disfavor as it implies a certainty or exactness that may not be possible by present dating methods; e.g., two "absolute" ages for the same pluton may disagree by hundreds of millions of years.

absolute age determination *numerical age determination.*

absolute chronology *numerical chronology.*

absolute date *numerical date.*

absolute datum A geodetic datum in which the reference ellipsoid is Earth-centered with its minor axis corresponding to the Earth's axis of rotation. See also: *geocentric geodetic datum.*

absolute gravity An absolute value of the *gravitational acceleration* due to the attraction of the Earth's mass, as opposed to its relative values such as measured by conventional gravimeters. It varies from about 9.78 m/sec^2 (978,000 mGal) at the equator to about 9.83 m/sec^2 (983,000 mGal) at the poles. Measurements are usually made at regional base stations of the world-wide network using the same type instruments. Portable absolute gravimeters are now in use. See also: *International Gravity Standardization Net 1971; absolute-gravity instrument.*

absolute-gravity instrument A device for measuring the actual value of the Earth's gravitational acceleration at a point with all of the physical influences evaluated with extreme accuracy. Measurements are accomplished by various forms of reversible pendulums or by timing the motion of a body in free fall. Cf: *relative-gravity instrument.*

absolute humidity The content of water vapor in air, expressed as the mass of water per unit volume of the humid air. Cf: *relative humidity; specific humidity.*

absolute permeability The ability of a rock to conduct a fluid, e.g. gas, at 100% saturation with that fluid. See also: *effective permeability; relative permeability.*

absolute pollen frequency An estimate of the actual amount of pollen deposited per unit area in a given length of time, achieved by correcting the amount of pollen per gram of sediment by factors based on rate of sedimentation. Abbrev: APF.

absolute time *numerical time.* Jeletzky (1956, p.681) proposed that the term be abandoned, because its usage, based on criteria peculiar to the Earth and having the present part of geologic history as its starting point, is "incorrect and highly misleading".

absolute viscosity *viscosity coefficient.*

absolute vorticity The sum of *relative* and *planetary vorticity.*

absorbed water (ab-sorbed') (a) Water retained mechanically within a soil mass and having properties similar to those of ordinary water at the same temperature and pressure. (b) Water entering the lithosphere by any means. Cf: *adsorbed water.*

absorptance (ab-sorp'-tance) The ratio of the energy absorbed by a material to that incident upon it. Syn: *absorption coefficient.*

absorption (ab-sorp'-tion) Taking up, assimilation, or incorporation; e.g., of liquids in solids or of gases in liquids. Cf: *adsorption.* Syn: *occlusion.*

absorption [grd wat] The entrance of surface water into the lithosphere by any method. Verb: to absorb. Cf: *adsorption.*

absorption [optics] The reduction of light intensity in transmission through an absorbing substance or in reflection from a surface. In crystals, the absorption may vary with the wavelength or vibration direction of the transmitted light.

absorption [phys] Any mechanism by which energy, e.g., electromagnetic or seismic, is converted into heat.

absorption band The wavelength interval at which electromagnetic radiation is absorbed by the atmosphere or by other media, e.g. an atmospheric absorption band at 5 to 8 μm, caused by water vapor that absorbs thermal infrared radiation of those wavelengths. Cf: *absorption spectrum; absorption line.*

absorption coefficient The rate of exponential decrease in amplitude. If the amplitude A is expressed as $A=A_0e^{-\alpha x}$, where x is the distance, α is the absorption coefficient. See: *Q [seis].*

absorption edge The wavelength at which there is an abrupt change in the intensity of an *absorption spectrum*. The term is usually applied to X-ray spectra.

absorption line Any of the dark lines in the *absorption spectrum* of a substance due to certain wavelengths in the spectrum being selectively absorbed on passing through a medium. Cf: *absorption band.*

absorption loss Water lost through *absorption* by rock and soil during the initial filling of a reservoir.

absorption spectroscopy The group of analytical techniques that involves determination and measurement of atomic and molecular energy levels (*spectrometry*), chemical identification, and molecular structure based on how the atoms and molecules absorb electromagnetic radiation. See also: *absorption spectrum; spectroscopy*.

absorption spectrum The characteristic spectrum that a substance capable of absorbing electromagnetic radiation produces when it is observed with a *spectroscope*. Black lines or bands appear where energy has been removed from the *continuous spectrum* by an absorbing medium. See also: *absorption spectroscopy; emission spectrum; spectroscopy; line spectrum; band spectrum.*

absorptivity (ab-sorp-tiv'-i-ty) The ability of a material to absorb energy incident upon it.

abstraction [streams] (ab-strac'-tion) The merging of two or more subparallel streams into a single stream course, as a result of competition between adjacent consequent gullies and ravines, as by the deepening and widening of one channel so that it absorbs a shallower and smaller one nearby; the simplest type of capture. It usually occurs at the upper end of a drainage line.

abstraction [water] That part of precipitation that becomes part of groundwater and is withdrawn from a well. Cf: *precipitation excess; rainfall excess.*

abswurmbachite A black tetragonal mineral: $Cu^{2+}Mn^{3+}_{6}O_8(SiO_4)$.

abtragung The part of degradation not resulting directly from stream erosion, i.e. preparation and reduction of rock debris by weathering and transportation of waste (Engeln, 1942, p.265). Etymol: German "Abtragung", "degradation; denudation".

abukumalite (ab-u-ku'-ma-lite) *britholite-(Y).*

Abukuma-type facies series (Ab-u-ku'-ma) Rocks produced in a type of dynamothermal regional metamorphism named after the Central Abukuma plateau of Japan, and characterized by the index minerals (in order of increasing metamorphic grade) biotite-andalusite-cordierite-sillimanite, representing the greenschist and amphibolite or hornblende-hornfels facies. Pressures are low, approaching those in contact metamorphism, i.e. 250-350 MPa (Hietanen, 1967, p.192). Cf: *Buchan-type facies series.*

abundance [ecol] (a-bun'-dance) In ecology, the number of individuals of a particular taxon in a certain area or volume of sediment. See also: *absolute abundance; relative abundance.*

abundance [geochem] The mean concentration of an element in a geochemical reservoir, e.g. the abundance of Ni in meteorites, or the crustal abundance of oxygen. Also used for relative average content, e.g. the order of abundance of elements in the Earth's crust is O, Si, Al, Fe, Ca, etc.; the estimated cosmic abundance of Li in atoms per 10,000 atoms of Si is 1.0 (Suess and Urey, 1956).

abundance, elemental [meteorite] Abundance, *in the strict sense,* means a doubly normalized atomic ratio (e.g., to the element Si and CI chondrites). Commonly also used as a synonym of weight concentration.

abundance of isotopes of an element Determined by mass spectrometry.

abundance-reserve relationship A method for estimating recoverable reserves of metals from crustal abundance data proposed by McKelvey (1960). McKelvey plotted recoverable reserves in the United States for several metals against their crustal abundance and proposed a general relationship $R = A \times 10^k$, where R is the tonnage of recoverable metal, A is crustal abundance in percent, and k is a number from 9 to 10 (Harris, 1984).

abundance zone (a) A *biozone* characterized by quantitatively distinctive maxima of relative abundance of one or more taxa (NACSN, 1983, Art. 52). Syn: *acme zone.* (b) A *stratum* or body of strata in which the abundance of a particular taxon or specified group of taxa is significantly greater than is usual in the adjacent parts of the section, regardless of either association or range (ISSC, 1994, p.63-64).

abundant (a-bun'-dant) In the description of coal constituents, 30-60% of a particular constituent occurring in the coal (ICCP, 1963). Cf: *rare; common; very common; dominant [coal].*

abyss [geomorph] (a-byss') *chasm.*

abyss [oceanog] Ocean environment at great depth.

abyssal [intrus rocks] (a-bys'-sal) (a) Pertaining to an igneous intrusion, of the resulting rock, formed at considerable depth; *plutonic.* (b) The same from the bottom of the ocean. Cf: *hypabyssal.*

abyssal [lake] Pertaining to great depths in a lake. Hutchinson (1967, p.241) questioned the utility of the term.

abyssal [oceanog] Pertaining to the ocean environment or depth zone of between 3,500 and 6,000 m; also, pertaining to the organisms of that environment.

abyssal benthic Pertaining to the benthos of the abyssal zone of the ocean. Syn: *abyssobenthic.*

abyssal cone A type of *submarine fan.*

abyssal fan Submarine fan at great depth.

abyssal gap A passage that connects two abyssal plains of different levels, through which clastic sediments are transported. Syn: *gap [marine geol].*

abyssal hill A common low-relief feature of the ocean floor, usually found in basins isolated by ridges, rises, or trenches. Abyssal hills are defined as less than 1 km in relief (>1 km is termed a seamount) and several kilometers in diameter. About 85% of the Pacific Ocean floor and 50% of the Atlantic Ocean floor are covered by abyssal hills.

abyssal pegmatite Feldspar-quartz pegmatite formed under conditions of granulite metamorphism (~4 to 9 kilobars pressure), and sometimes associated with migmatitic granite.

abyssal pelagic Pertaining to the open-ocean or pelagic environment at abyssal depths. Syn: *abyssopelagic.*

abyssal peridotite Serpentinized and altered peridotite of oceanic ridges. "Abyssal peridotites are widely accepted as residues of pressure-release melting accompanying upward convection of the mantle beneath mid-ocean ridges" (Dick, 1989).

abyssal plain A flat region of the deep ocean floor, whose slope is less than 1:1,000. It is formed by the deposition of gravity-current and pelagic sediments that obscure the preexisting topography.

abyssal theory A theory of mineral-deposit formation involving the separation and sinking of minerals below a silicate shell during the cooling of the Earth from a liquid stage, followed by their transport to and deposition in the crust as it was fractured (Shand, 1947, p.204). Modern thought has completely negated such theories.

abyssal tholeiite *mid-ocean-ridge basalt.*

abyssobenthic (a-byss'-o-ben'-thic) *abyssal benthic.*

abyssolith (a-byss'-o-lith) Obsolete syn. of *batholith.*

abyssopelagic (a-byss'-o-pe-lag'-ic) *abyssal pelagic.*

acadialite (a-ca'-di-a-lite') A flesh-red variety of chabazite, found in Nova Scotia.

Acadian (A-ca'-di-an) North American provincial series: Middle Cambrian (above Georgian, below Potsdamian). Obsolete syn. of *Albertan.*

Acadian Orogeny A middle Paleozoic deformation event, especially in the northern Appalachians; it is named for Acadia, the old French name for the Canadian Maritime Provinces. The climax of the orogeny can be dated stratigraphically as early in the Late Devonian, but deformational, plutonic, and metamorphic events occurred over a more extended period; the last two have been dated radiometrically as between 330 and 360 m.y. ago. The Acadian is probably a consequence of convergent-margin tectonism and collision of exotic terranes with the eastern margin of North America. For example, the Avalon platform probably docked during the Acadian. Cf: *Antler Orogeny.*

acalymmate (a-ca-lym'-mate) In obligate *tetrads* or *polyads,* not having the *ectexine/sexine* form a single continuous envelope around the unit. Cf: *calymma.* Ant: *calymmate.*

acantharian (ac-an-tha'-ri-an) Any radiolarian belonging to the suborder Acantharina, characterized by a centrogenous skeleton composed of strontium sulfate and a central capsule enclosed by a thin simple membrane.

acanthine septum (a-can'-thine) A *corallite septum* composed of a vertical or steeply inclined series of trabeculae and commonly marked by spinose projections along the axially directed margin of the septum.

acanthite (a-can'-thite) A metallic black monoclinic mineral: Ag_2S. It is dimorphous with argentite and constitutes an ore of silver.

Acanthodii (Ac-an-tho'-di-i) A subclass of the Osteichthyes characterized by fixed paired fins supported anteriorly by spines; more than two pairs are usually present. It includes the oldest recorded gnathostomes (Upper Silurian). Range, Upper Silurian to Lower Permian.

acanthomamilla (a-can-tho-ma-mil'-la) In palynomorphs, a sculptural element consisting of a hemispheroidal base surmounted by a sharply contracted spine; e.g., in dibolisporites.

acanthomorph (a-can'-tho-morph) An *acritarch* having a spherical or ellipsoidal *vesicle* with prominent simple or branching *processes* (Mendelson, 1993; Williams et al., 2000).

acanthopore (a-can'-tho-pore) A small rodlike skeletal structure, originally believed to be hollow, consisting of a solid core surrounded by a sheath of cone-in-cone laminae lying within zooecial walls or extrazooidal skeleton in stenolaemate bryozoans. Acanthopores form spinelike projections at the colony surface.

acanthostyle (a-can'-tho-style) A monaxonic sponge *spicule* (style) covered with short or tiny spines over most of its surface.

acanthus (a-can'-thus) A secondary deposit in the chamber floor of certain foraminifers (such as *Endothyra*), sharply pointed but not curved toward the anterior (TIP, 1964, pt. C, p.58). Pl: acanthi.

acapulcoite A group of meteorites with chondritic mineral compositions in roughly chondritic proportions, thought to have been formed by a low degree of partial melting and segregation of Fe. See: *primitive achondrite.*

acarid (ac'-a-rid) Any arachnid belonging to the order Acarida, characterized by the absence of abdominal segmentation but with subdivision of the body into a proterosoma and hysterosoma. Range, Devonian to present.

acaustobiolith (a-caust'-o-bi'-o-lith) A noncombustible organic rock, or a rock formed by the organic accumulation of purely mineral matter (Grabau, 1924, p.280). Rarely used. Cf: *caustobiolith.*

acavate (a-ca'-vate) In *palynomorphs,* lacking a cavity between wall layers (Williams et al., 2000, p.2). Ant: *cavate.*

accelerated development (ac-cel'-er-at'-ed) The hypothetical change in a landscape where the rate of uplift is more rapid than the rate of downward erosion or where valley deepening exceeds valley widening, characterized by an increase of the relative relief and the formation of convex slopes. Cf: *declining development; uniform development.* Syn: *waxing development; ascending development.*

accelerated erosion Erosion occurring in a given region at a greater rate than *normal erosion,* usually brought about by the influence of human activities in disturbing or destroying the natural cover, thus sharply reducing resistance of the land surface and rate of infiltration. It may result from deforestation, improper cultivation of soil, dry-farming, overgrazing of rangelands, burning and clearance of natural vegetation, excavation for buildings and highways, urbanization of drainage areas, strip mining, or copper smelting; and by nonhuman influences, such as lightning-ignited wildfire or rodent invasion.

acceleration (ac-cel'-er-a'-tion) (a) During evolution, the appearance of modifications earlier and earlier in the life cycle of successive generations; adult characters of the ancestor appear earlier in immature stages of the descendants (*tachygenesis*), sometimes to the point that certain steps are omitted (*brachygenesis*). (b) In Paleozoic corals, the addition of more secondary septa in one pair of quadrants than in the other pair.

acceleration due to gravity The acceleration of a freely falling body in a vacuum as a result of gravitational attraction. Although its value varies with altitude, latitude, and the nature of the underlying rocks, the standard value of 980.665 cm/sec^2 has been adopted by the International Committee on Weights and Measures.

accelerator mass spectrometry A type of *mass spectrometry* that relies on high-voltage accelerators and provides ultra-high dynamic range. It is capable of measuring isotopic ratios as small as 10^{-16}. Abbrev: AMS.

accelerometer (ac-cel'-er-om'-e-ter) (a) A *seismometer* whose response is linearly proportional to the acceleration of earth materials with which it is in contact. (b) A *transducer* whose output is proportional to the acceleration. Accelerometers are used in shipboard gravimeter systems, in inertial navigation, and in some airborne gravity measuring systems (Fairhead and Odegard, 2002). The measured acceleration is relative to the rotation of the Earth; it is nonequilibrium acceleration, not simply acceleration of gravity. Cf: *aerogravity.*

accented contour (ac'-cent-ed) *index contour.*

accessible geothermal resource base That part of the geothermal resource base at depths shallow enough to be tapped by drilling in the foreseeable future (Muffler and Cataldi, 1978; Muffler, 1985). Includes identified and undiscovered components.

accessory [mineral] (ac-ces'-so-ry) *accessory mineral.*

accessory [paleont] adj. Said of a secondary or minor element of an ammonoid suture; e.g. "accessory lobe" or "accessory saddle". Also said of a secondary shelly addition to a bivalved molluscan shell. Cf: *auxiliary.* n. Such a lobe or saddle.

accessory [pyroclast] Said of pyroclastic materials that are formed from fragments of the volcanic cone or earlier lavas; it is part of a classification of volcanic ejecta based on mode of origin, and is equivalent to *resurgent* ejecta. Cf: *essential; accidental.* See also: *cognate [pyroclast].*

accessory aperture An opening in the test of a planktonic foraminifer that does not lead directly into a primary chamber but extends beneath or through accessory structures (such as bullae and tegilla); e.g. a *labial aperture,* an *infralaminal accessory aperture,* and an *intralaminal accessory aperture.*

accessory archeopyle suture An *archeopyle suture* that consists of a short cleft in the wall adjacent to the principal suture, or that may be more fully developed on the operculum of the dinoflagellate cyst, dividing that structure into two or more separate pieces.

accessory calcification [paleont] Any calcification by the molluscan mantle epithelium that is not an integral component of the normal shell plates, ligament, or periostracum, e.g., separate shell plates adjacent to the normal shell margins in corbulids and pholads, callum and pallet calcification in pholads, encrustations on the exterior of the periostracum in lithogaginids, tubes secreted by burrowing species, and burrow linings secreted by boring species in the Pholadacea and Gastrochaenacea (Carter, 1980a, p.77). The term is partly synonymous with the "Kalktapete" of Bandel and Keupp (1985).

accessory comb The line of large cilia within the preoral cavity in a tintinnid.

accessory element *trace element.*

accessory lobe Nodose projection of anterior part of platform of some pectiniform conodont elements, situated between posterior end of blade and that part of platform crossed by transverse ridges (TIP, 1981, pt. W, supp.2).

accessory mineral A mineral whose presence in a rock is not essential to the proper classification of the rock. Accessory minerals generally occur in minor amounts; in sedimentary rocks, they are mostly *heavy minerals.* Cf: *essential mineral [petrology].* Syn: *accessory [mineral].*

accessory muscle (a) A convenient noncommittal term for any muscle of a bivalve mollusk (other than an *adductor muscle* or a muscle withdrawing marginal parts of the mantle) of uncertain origin and having a scar of attachment to the shell. (b) One of a pair of diductor muscles branching posteriorly and ventrally from the main diductor muscles of a brachiopod and inserted in the *pedicle valve* posterior to the adductor bases (TIP, 1965, pt. H, p.139).

accessory spore A spore present in a rock only in very small quantities. Accessory spores may contain types with a restricted range and they have been used for correlation and for zoning (as of coal measures).

accident (ac'-ci-dent) (a) A departure from the normal cycle of erosion, caused by events that occur "arbitrarily as to place and time", such as climatic changes and volcanic eruptions (Davis, 1894). See also: *climatic accident; volcanic accident.* Cf: *interruption.* (b) An event, such as drowning, rejuvenation, ponding, or capture, that interferes with, or entirely puts an end to, the normal development of a river system (Scott, 1922, p.188). (c) An irregular feature in, or an undulation of, a land surface.

accidental (ac-ci-den'-tal) Said of pyroclastic materials that are formed from fragments of nonvolcanic rocks or from volcanic rocks not related to the erupting volcano; it is part of a classification of volcanic ejecta based on mode of origin, and is equivalent to *allothigenous* ejecta. Cf: *cognate [pyroclast]; accessory [pyroclast]; essential.* Syn: *noncognate.*

accidental error An unpredictable error that occurs without regard to any known mathematical or physical law or pattern and whose occurrence is due to chance only; e.g. an error ascribed to uncontrollable changes of external conditions. Syn: *random error.*

accidental inclusion *xenolith.*

accidented relief Rugged and irregular relief; probably a literal translation of the common French term "relief accidenté" (Stamp, 1961, p.4).

acclimation (ac-cli-ma'-tion) *acclimatization.*

acclimatization (ac-cli'-ma-ti-za'-tion) Physiologic adjustment by an organism to a change in its immediate environment. Syn: *acclimation.*

acclivity (ac-cliv'-i-ty) A slope that ascends from a point of reference. Ant: *declivity.*

accommodation The space made available for potential sediment accumulation. Accomodation is a function of sea-level rise, subsidence, or a combination of these two processes (Jervey, 1988). Accommodation refers to all the space available for sediment to fill, including old space (leftover from an earlier time) plus new space added; whereas new space added refers only to space contemporaneously being made available.

accommodation zone (a) A zone where local faulting and/or folding develops to accommodate room problems during the development of a larger structure, i.e. in the hinge zone of a fold. (b) A portion of a rift zone where the axis of extension and/or the regional dip of faults changes abruptly. (c) The area between two subparallel, non-collinear, overlapping faults along which displacement or strain is transferred from one fault to another. Rosendahl et al. (1986) specifically apply the term to the zone between *half grabens* whose *boundary faults* dip in opposite directions. Cf: *transfer zone.*

accordance of summit levels (ac-cord'-ance) *summit concordance.*

accordant (ac-cord'-ant) Said of topographic features that have the same or nearly the same elevation; e.g. an accordant valley whose stream enters the main stream at the same elevation as that of the main stream. Ant: *discordant [geomorph].*

accordant drainage Drainage that has developed in a systematic relationship with, and consequent upon, the present geologic structure. Ant: *discordant drainage.* Syn: *concordant drainage.*

accordant fold One of several folds having similar orientation.

accordant junction The joining of two streams or two valleys whose surfaces are at the same level at the place of junction. See also: *Playfair's law.* Ant: *discordant junction.* Syn: *concordant junction.*

accordant summit level A reconstructed level or gently sloping surface that regionally intersects hilltops or mountain summits. Accordant summit levels in a region of high topographic relief suggest that the summits are remnants of an erosion plain formed in a previous erosion cycle. See also: *summit concordance; even-crested ridge.* Syn: *concordant summit level.*

accordant summits Hilltops or mountain peaks that regionally reach the same hypothetical level or gently sloping surface. The term cannot be used in the singular.

accordion fold (ac-cor'-di-on) An old term, formerly used with genetic significance; now sometimes used as a syn. of *kink fold.* See also: *zigzag fold; chevron fold.* Syn: *angular fold; concertina fold.*

accreting plate boundary (ac-cret'-ing) A boundary between two plates that are moving apart, with new oceanic-type lithosphere being created at the seam (Dennis and Atwater, 1974, p.1033). See also: *mid-ocean ridge; spreading center; divergent plate boundary.* This older term is now avoided because it can be confused with the more recent concept of accretionary plate orogeny.

accretion [planet] (ac-cre'-tion) The process whereby small particles and gases in the solar nebula came together to form larger bodies, eventually of planetary size.

accretion [sed] (a) The gradual or imperceptible increase or extension of land by natural forces acting over a long period of time, as on a beach by the washing-up of sand from the sea or on a flood plain by the accumulation of sediment deposited by a stream. Legally, the added land belongs to the owner of the land to which it is added. Cf: *avulsion; reliction.* See also: *lateral*

accretion; vertical accretion. Syn: *aggradation [geomorph]; alluvion.* (b) The land so added or resulting from accretion. (c) *continental accretion.*

accretion [sed struc] (a) The process by which an inorganic body increases in size by the external addition of fresh particles, as by adhesion. (b) A *concretion;* specif. one that grows from the center outward in a regular manner by successive additions of material (Todd, 1903). (c) Deposition of eolian sand on a continuous sand surface because of a decrease in wind intensity or an increase in surface roughness (Bagnold, 1941, p.127).

accretion [streams] The filling-up of a stream bed, due to such factors as silting or wave action. Cf: *degradation [streams].*

accretion [struc geol] The addition of island-arc or continental material to a continent by convergent and transform motion, i.e. by collision and welding or suturing. Locally, very large volumes of material, containing slivers of ophiolite, are added by accretion. The tectonic incorporation of terranes into a continental framework (Howell, 1995). Cf: *continental accretion; amalgamation.* Syn: *tectonic accretion.*

accretionary (ac-cre'-tion-a'-ry) Tending to increase by external addition or accumulation; esp. said of a secondary sedimentary structure produced by overgrowth upon a preexisting nucleus, such as a rounded form that originated through rolling, or said of a limestone formed in place by slow accumulation of organic remains.

accretionary lapilli Spheroidal pellets, mostly between 1 mm and 1 cm in diameter, of consolidated or cemented ash. Formed by accretion of particles around wet nuclei, e.g. raindrops falling through a cloud of ash (Macdonald, 1972, p.133) or accretion in a wet surge cloud. Syn. for individual spheroids: *pisolite [volc]; tuff ball.*

accretionary lava ball A rounded mass, ranging in diameter from a few centimeters to several meters, formed on the surface of a lava flow such as *aa,* or on cinder-cone slopes, by the molding of viscous lava around a core of already solidified lava.

accretionary orogeny A period of deformation and continental growth involving suturing of exotic terrane to a continental margin during collision and convergence.

accretionary prism A generally wedge-shaped mass of tectonically deformed sediment at a *convergent plate boundary* formed when pelagic sediment, oceanic-floor basalt, and trench-fill turbidite are scraped off the downgoing plate during the process of subduction.

accretionary terrane An allochthonous mass of continental or oceanic material added to the margin of a continent by collision and welding.

accretion ridge A beach ridge located inland from the modern beach, representing an ancient beach deposit and showing that the coast has been built out seaward (Fisk, 1959, p.111). It is often accentuated by the development of dunes. Cf: *chenier plain.*

accretion ripple An asymmetric ripple having a gentle and curved *lee* slope, with a maximum angle of dip less than the *angle of repose,* and composed of cross-strata without conspicuous sorting of particles (Imbrie and Buchanan, 1965, p.151, 153).

accretion ripple mark *accretion ripple.*

accretion till *basal till.*

accretion topography A landscape built by accumulation of sediment or lava.

accretion vein *sheeted vein.*

accumulated discrepancy (ac-cu'-mu-lat'-ed) The sum of the separate discrepancies that occur in the various steps of making a survey or of computing the results of a survey.

accumulation (ac-cu'-mu-la'-tion) (a) All processes that add snow or ice to a glacier, to floating ice, or to the snow cover, including snowfall, condensation, avalanching, drifting, and freezing of liquid water. Syn: *alimentation; nourishment [glaciol].* Cf: *ablation [glaciol]* (b) The amount of snow and other solid precipitation added to a glacier or snowfield by the processes of accumulation.

accumulation area The part of a glacier or snowfield in which, over a year's time, accumulation exceeds ablation; the region above the *equilibrium line.* Cf: *ablation area; névé.* Syn: *firn field; accumulation zone; zone of accumulation [snow].*

accumulation-area ratio The ratio of accumulation area to total area of a glacier for any given year, used as a rough guide to the balance between accumulation and ablation. Abbrev: AAR.

accumulation body A solid mass within the cell of a dinoflagellate that is assumed to be metabolic waste material (Williams et al., 2000, p.3).

accumulation mountain *mountain of accumulation.*

accumulation rate The amount of ice or snow gain per unit time to a glacier, floating ice, or snow cover. Usually expressed in millimeters of water equivalent per hour or day or year.

accumulation season In glaciology, that period of a year when the balance of a glacier increases to the maximum for the year. This is the part of the year when, on the average, accumulation exceeds ablation. Syn: *winter season.*

accumulation zone (a) *accumulation area.* (b) The area in which the bulk of the snow contributing to an avalanche was originally deposited. Syn: *zone of accumulation [snow].*

accumulative rock (ac-cu'-mu-la'-tive) *cumulate.*

accumulator plant (ac-cu'-mu-la'-tor) In geobotanical prospecting, a tree or plant that preferentially concentrates an element.

accuracy (ac'-cu-ra-cy) The degree of conformity with a standard, or the degree of perfection attained in a measurement. Accuracy relates to the quality of a result, and is distinguished from *precision,* which relates to the quality of the operation by which the result is obtained.

ACD *aragonite compensation depth.*

AC demagnetization *alternating-field demagnetization.*

A-centered lattice A *base-centered lattice* that is centered in the pair of (100) faces. Cf: *B-centered lattice; C-centered lattice.*

acequia (a-ce-qui'-a [ah-se-kee'-ah]) A Spanish word, of Arabic origin, for an irrigation ditch or canal.

acervuline (a-cer'-vu-line) Heaped, or resembling little heaps; e.g. said of some foraminifers (such as *Acervulina*) having chambers in irregular clusters.

acetamide (ac-et-am'-ide, ac-et'-am-ide) A colorless to gray trigonal organic mineral: CH_3CONH_2.

acetolysis (ac-e-tol'-y-sis) Any chemical reaction in which acetic anhydride plays a role similar to that of water in hydrolysis; e.g. a reaction used in maceration in which organic material such as peat is heated in a mixture of nine parts acetic anhydride and one part concentrated sulfuric acid. It breaks down cellulose especially vigorously.

ACF diagram A triangular diagram showing the simplified compositional character of metamorphic rocks and minerals by plotting the molecular quantities of the three components: $A = Al_2O_3 + Fe_2O_3 - (Na_2O + K_2O)$; $C = CaO - 3.3P_2O_5$; and F=FeO + MgO + MnO. A+C+F (in mols) are recalculated to 100%; the presence of excess SiO_2 is assumed. Cf: *AFM diagram; A'KF diagram.*

achavalite (a-cha-val'-ite) A metallic hexagonal mineral: FeSe.

achene (a-chene') A dry one-seeded indehiscent fruit developed from a simple ovary with unfused seed coat and fruit wall. Also spelled: *akene.*

achlamydate (ach-lam'-y-date) Said of a gastropod without a mantle.

achnelith (ach'-ne-lith) A term used by Walker and Croasdale (1972) to describe droplets from Strombolian lava fountaining. Etymol: Greek "achne," "spray, froth."

achoanitic (a-cho'-a-nit'-ic) Said of the condition in a nautiloid in which septal necks are vestigial or absent. Syn: *aneuchoanitic.*

achondrite (a-chon'-drite) A differentiated *stony meteorite;* as implied by the name, it lacks chondrules. Achondrites are commonly more coarsely crystallized than chondrites, and nickel-iron is almost completely lacking in most of them; most are brecciated. Adj: achondritic. Cf: *chondrite [meteorite]; iron meteorite.* Syn: *differentiated meteorite.*

achroite (a-chro'-ite) A colorless variety of tourmaline, used as a gemstone.

acicular [cryst] (a-cic'-u-lar) Said of a crystal that is needlelike in form. See also: *fascicular; sagenite.*

acicular [sed] Said of a sedimentary particle whose length is more than three times its width (Krynine, 1948, p.142). Cf: *platy.*

acicular ice Freshwater ice consisting of numerous long crystals and hollow tubes having variable form, layered arrangement, and a content of air bubbles; it forms at the bottom of an ice layer near its contact with water. Syn: *fibrous ice; satin ice.*

aciculate (a-cic'-u-late) Needle-shaped, or having a needlelike point; esp. said of a slender gastropod shell that tapers to a sharp point.

acid adj. (a) *silicic.* (b) *acidic.* (c) Said of a plagioclase that is sodic.

acid clay A clay that yields hydrogen ions in a water suspension; e.g. "Japanese acid clay", a variety of fuller's earth occurring in Kambara, Japan.

acidic (a-cid'-ic) (a) A descriptive term applied to those igneous rocks that contain more than 60% SiO_2, as contrasted with *intermediate* and *basic.* Sometimes loosely and incorrectly used as equivalent to *felsic* and to *oversaturated,* but these terms include rock types (e.g., nepheline syenite, quartz basalt) that are not generally considered acidic. This is not the chemist's usage; the term is deprecated by some because of its confusing nature. (b) Applied loosely to any igneous rock composed predominantly of light-colored minerals having a relatively low specific gravity. Cf: *felsic.* Syn: *acid; silicic.*

acidity coefficient (a-cid'-i-ty) *oxygen ratio.*

acidity quotient *oxygen ratio.*

acidization (ac'-id-i-za'-tion) The process of forcing acid down a well into a limestone or dolomite, in order to increase permeability and porosity by dissolving a part of the rock constituents. It is also used to remove mud injected during drilling. The general objective of acidization is to increase oil productivity. Syn: *acid treatment.*

acid job A method of well stimulation for an oil or gas well that may produce from a carbonate (e.g. limestone) reservoir or one cemented with carbonate minerals. Commonly used acids are hydrochloric, citric or acetic acids. The process is intended to dissolve the carbonate to increase productivity of that reservoir.

acid mine drainage Drainage with a pH of 2.0 to 4.5 from mines and mine wastes or from constructed excavations, such as road cuts or tunnels. It results from the oxidation of sulfides exposed during excavation, which produces sulfuric acid and sulfate salts.

acid neutralizing capacity The amount of acid that can be neutralized by the cations dissolved in lake water (Wetzel, 2001, p.191). Cf: *alkalinity [lake].*

acid plagioclase A variety of plagioclase having a relatively high content of SiO_2; e.g. an Ab-rich member such as albite or oligoclase.