

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/R-99/006
January 1999

Research and Development

A Lexicon of Cave and Karst Terminology with Special Reference to Environmental Karst Hydrology

A LEXICON OF CAVE AND KARST TERMINOLOGY
WITH SPECIAL REFERENCE
TO ENVIRONMENTAL KARST HYDROLOGY

National Center for Environmental Assessment-Washington Division
Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC 20460

DISCLAIMER

The document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

CONTENTS

PREFACE	iv
AUTHOR AND REVIEWERS	v
INTRODUCTION	1
GLOSSARY OF TERMS	3
A	4
B	14
C	24
D	50
E	61
F	66
G	73
H	81
I	88
J	94
K	95
L	101
M	107
N	115
O	118
P	121
Q	135
R	136
S	145
T	171
U	180
V	183
W	186
Y	191
Z	192
REFERENCES	193

PREFACE

The National Center for Environmental Assessment-Washington Division (NCEA-W) has prepared this document for the benefit of the regional offices and general public to satisfy the need to understand the terminology common to the field of karst. This document is a glossary of most terms that have some relationship to the field of environmental karst, as well as specific karst terms. It includes many foreign terms because much karst research is conducted in foreign countries and published using local terminology. In many instances common environmental terms are defined in such a way as to specifically reference karstic phenomena.

The purpose of this document is to serve as a technical guide to regional offices and the public in general who must read the karst literature or hold discussions with karst researchers. It is intended that this document remove much of the confusion surrounding many karst terms.

The literature search supporting this lexicon is current to 1998.

AUTHOR AND REVIEWERS

The National Center for Environmental Assessment-Washington Division within the U.S. Environmental Protection Agency's Office of Research and Development was responsible for the preparation of this document and provided overall direction and coordination during the production effort.

Author/Compiler

Malcolm S. Field, Ph.D.
National Center for Environmental Assessment-W
U.S. Environmental Protection Agency
Washington, DC

Reviewers

Stephen R. Kraemer, Ph.D.
U.S. Environmental Protection Agency
National Exposure Research Laboratory
Ecosystems Research Division
Athens, GA

Arthur N. Palmer, Ph.D.
Department of Earth Sciences
State University of New York
Oneonta, NY

INTRODUCTION

Several attempts to classify karst terminology in an organized manner have been made in the past. The last few glossaries of karst terminology were organized in the late 1960s and published in the early 1970s. Since that time, many new terms related to karst have come into use, while other, older karst terms are seldom used nowadays. In the mid 1990s the British Cave Research Association (BCRA) published an updated dictionary that covers the general area of karst and caves, but did not focus on environmental issues.

Many of the more recent karst terms are related to the upsurge in environmentalism and the recognition among karst cognoscenti that karst terranes are much more sensitive to human-induced effects on the environment than are other types of landscapes. In an attempt to be as broad as possible in this glossary, terms related to general hydrology and hydrogeology, common karst rock and mineral types, and many of the descriptive terms used in speleology, even where they relate to specific localities, have been included. No attempt was made to exclude foreign karst terms, although many are no doubt missing. This has led to a much larger manuscript than was originally intended when this project was initiated, but it has provided for a more comprehensive document.

Because many non-karst professionals, whether working on basic research or on environmental problems, need to have a general working knowledge of karst terminology, this glossary was developed to provide an up-to-date reference for more modern definitions of karst terms both currently in usage and now defunct. As with any undertaking of this sort, numerous omissions will be evident. In other instances, disagreements regarding definitions will arise. In the event that readers of this glossary find omissions or incorrect definitions, it would be greatly appreciated if the necessary corrections be forwarded to this office so that the glossary may be updated in the future.

As a final note, it should be pointed out that a list of references for the definitions is included at the back of this glossary and citations provided when appropriate. In many instances duplication of definitions from previous glossaries was employed to avoid changing the original definitions. However, efforts were not always attempted to cite the exact source for each definition, as this would have greatly lengthened this already excessively long manuscript; secondary citations have been provided. Exact citations would also have resulted in confusion where several previous definitions

were utilized in the writing of a single clear definition for any particular term. In no instance was it intended that the work of others be appropriated, only that this glossary be as comprehensive and clear as possible while avoiding excessive clutter. Also, where definitions were deemed to be incorrect or poorly worded, alternatives were written.

GLOSSARY OF TERMS

A

abîme. (French.) 1. An abyss. 2. A wide, deep shaft, in limestone, the walls of which are vertical or overhanging^[10].

ablation. The wearing away of ice or snow through the process of evaporation^[16].

abris sous roche. (French.) See *rock shelter*.

absorption. The process by which substances in gaseous, liquid, or solid form dissolve or mix with other substances^[22].

abyss. Extremely great depth^[16].

accelerated corrosion. A localized concentration of solution intensity, produced by factors favoring greater aggressivity of the water in certain parts of the karstland creating differential solution rates and thereby a marked unevenness in the overall erosion of the karstland^[19]. See also *corrosion*; *alluvial corrosion*.

accessory mineral. Mineral constituents of a rock occurring in very small amounts^[16].

acclivity. Ascending a slope^[16].

accretion. Land addition by sediment deposition of a stream^[16].

accumulation. Building of new land by addition of sedimentary deposits^[16].

acid. Any chemical compound containing hydrogen capable of being replaced by positive elements or radicals to form salts. In terms of dissociation theory, it is a compound which, on dissociation in solution, yields excess hydrogen ions.

Acids lower the *pH*. Examples of acids or acidic substances are hydrochloric acid, tannic acid, and sodium acid pyrophosphate^[6].

acidity. The property of water having a *pH* below 4.5 that is caused by the presence of mineral acids. Usually expressed in equivalent amounts of calcium carbonate^[16]. See also *alkalinity*; *pH*.

acid mine drainage. Acid waters originating from surface or underground mine workings^[16].

acoustic log. Geophysical borehole log measuring the speed of sound in rocks to determine porosity^[16].

acoustic resistance. The product of wave velocity and rock density indicating the reflective power of a boundary between two strata^[16].

activated charcoal, activated carbon. A granular material usually produced by the roasting of cellulose base substances, such as wood or coconut shells, in the absence of air. It has an extremely porous structure and is used in water conditioning as an adsorbent for organic matter and certain dissolved gases^[6]. It is especially useful for adsorbing tracer dyes.

active cave. 1. Cave containing a running stream. 2. Cave in which speleothems are growing. (Less common and less desirable usage.) Compare *live cave*^[10].

active glacier. Glacier in the stage of actively enlarging and moving as a result of accumulation of precipitation that exceeds the rate of ablation.

active water. Water with corrosive properties^[16].

adiabatic. The property of thermodynamic process with no heat exchange^[16].

adjusted stream. Stream flowing parallel to the strike of underlying beds^[16].

adsorption. Adherence of gas molecules, ions, or molecules in solution to the surface of solids^[22].

adsorption isotherm. A graphical representation of the relationship between the bulk activity of adsorbate and the amount adsorbed at constant temperature^[22].

advection. 1. The process whereby solutes are transported by the bulk mass of flowing fluid^[6]. 2. Phenomenon of a cool air mass intruding and interrupting evaporation and causing condensation due to heat loss^[16]. See also *convective transport*.

aeolianite. See *eolian calcarenite*.

aeration. The process of bringing air into intimate contact with water, usually by bubbling air through the water to remove dissolved gases such as carbon dioxide and hydrogen sulfide or to oxidize dissolved materials such as iron compounds^[6].

aeration, zone of. See *zone of aeration*.

aerial photograph. Photograph of the landscape taken from an airplane. Synonym *air photo*. See also *stereo aerial photographs*.

aerobic. A property of aquatic life forms that can exist only in the presence of oxygen. See also *anaerobic*.

age of caves. The ages of individual caves may vary enormously. In most regions the youngest cave passages have reached their present dimensions during the past 10,000 years, or since the last Pleistocene glacial retreat. In higher latitudes most caves can be related to erosion during the later Pleistocene climatic variations of the past million years, and older caves have largely been removed by continuing surface lowering. In tropical regions less interrupted erosion conditions have encouraged survival of older caves; the Mulu caves of Sarawak include large passages at least two million years old. Relict caves hundreds of millions of years old may survive in some buried limestones, but are commonly filled with younger sediments (see *neptunian deposits*), minerals or, very rarely, igneous rocks. These fill materials may themselves be dateable, either on the basis of contained fossil material (including pollen), by comparison with similar rock types that occur at the surface, or by isotopic age determination methods identical to those applied to suitable surface rock materials. See also *dating of cave sediments*^[9].

aggradation. Land addition through sediment deposition^[16].

aggrading river. A river that is actively elevating its bed by deposition of sediments^[16].

aggregate. Grain mixture loosely held together^[16].

aggregation. The formation of aggregates. In drilling fluids, aggregation results in the stacking of the clay platelets face to face; as a result, viscosity and gel strength decrease^[6].

aggressive water. 1. Water having the ability to dissolve rocks. In the context of limestone and dolomite, this term refers especially to water containing dissolved carbon dioxide to form carbonic acid or, rarely, other acids. 2. Quality of waters that attack metals and concrete chemically by dissolution^[10].

aggressiveness. A measure of the relative capacity of water to dissolve rock material. In the context of karstification and speleogenesis this usually concerns the dissolution of limestone or dolomite by the action of dissolved carbon dioxide (carbonic acid), though other acids may also be involved^[9].

aguada. (Spanish for “watering place.”) In Yucatán, shallow depression generally covering several hectares used for water supply^[10].

A-horizon. The topmost eluviated horizon of a soil profile^[16].

aîle. See *aisle*.

air pocket, air bell. 1. An enclosed air space between the water surface and the roof of a cave^[10]. 2. Part of a flooded passage where the ceiling rises above the water level to create an air pocket isolated from the rest of the cave^[9].

air separating tank. A tank in which desorbed gases are separated from a liquid and evacuated by pumping^[16].

air-space ratio. The ratio of (a) the volume of water that can be drained from a saturated soil or rock under the action of force of gravity to (b) the total volume of voids^[22].

aisle. An elongated high narrow traversable passage in a cave^[10]. See also *crawl*, *crawlway*; *corridor*; *passage*. Synonyms: (French.) *aisle*, *aîle*; (German.) *Kluft*; (Greek.) *farangothes ipoyios thiavasis*; (Russian.) *hod*; (Spanish.) *laminador vertical*; (Turkish.) *dar geçit*; (Yugoslavian.) *niša*.

albedo. The ratio of reflected radiation to total radiation on a natural surface^[16].

algal limestone. Type of limestone formed by calcium-secreting algae^[16].

alkali flat. A salt-covered or heavily saline depression in an arid environment^[16].

alkaline. Any of various soluble mineral salts found in natural water and arid soils having a *pH* greater than 7. In water analysis, it represents the carbonates, bicarbonates, hydroxides, and occasionally the borates, silicates, and phosphates in the water^[6].

alkalinity. The property of water to neutralize acids. Usually expressed in terms of calcium carbonate equivalents^[16]. See also *acidity*; *pH*.

allochthonous. Said of material originating from a different locality than the one in

which it has been deposited^[16]. See also *autochthonous*.

allochthonous drainage. Less common synonym for *allogenic drainage*^[9].

allogene stream. A surface-water course flowing over a karst terrane, but fed by a spring (or springs) issuing from a nonkarst terrane^[20]. Synonyms: (French.) *rivière allogène (cours d'eau)*; (German.) *allochthoner Fluss* (all. *Waßerlauf*); (Greek.) *allothigenes ryax*, or *potamos*; (Italian.) *corso d'acqua allogeno*; (Spanish.) *río alóctono*; (Turkish.) *karst disi kökenli akarsu*; (Yugoslavian.) *alogen a rijeka*, *alogen a reka*.

allogenic. Formed or generated elsewhere, usually at a distant place^[11]. See also *autogenic*; *recharge*, *allogenic*; *recharge*, *autogenic*.

allogenic drainage. Underground karst drainage that is derived entirely from surface runoff that originates on adjacent nonkarstic, generally impermeable rocks. Also *allochthonous drainage*. See also *autogenic drainage*^[9].

allogenic valley. A karst valley incised by a watercourse originating on impervious rock with a volume sufficient for it to traverse a limestone area on the surface. The valley is incised from the limestone contact, and with the passage of time the river is increasingly likely to pass underground as the waters enlarge joints. Occasionally such a valley may represent the large-scale collapse of the cavern system along a subterranean stream or the enlarging of a series of karst windows^[19].

alluvial. Pertaining to or composed of alluvium or deposited by a stream or running water^[6]. Also applies to material lining the floor of a cave and deposits at the mouth of a spring.

alluvial apron. A fanlike plain from the deposition of glacial outwash^[16].

alluvial channel. River or stream channel bed composed of unconsolidated alluvial material^[16].

alluvial corrosion. Greater intensity of solution, caused by the passage of water through unconsolidated deposits rich in carbon dioxide, thus increasing aggressivity^[19]. See also *corrosion*, *accelerated corrosion*.

alluvial fan. A fanlike deposit of detrital material from steep mountain slopes^[16].

alluvial plain. A plain formed by the deposition of waterborne sediments^[16].

alluvial veneer. A very thin cover of waterborne sediments^[16].

alluvium. A general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semisorted sediment in the bed of the stream, or on its floodplain or delta, or as a cone or fan at the base of a mountain slope^[6].

alpine karst. 1. Karst formed at high latitude, or in polar regions regardless of altitude. 2. Almost synonymous with glaciokarst, but restricted to areas of high altitude and

relief^[9]. Synonyms: *glaciokarst*; *nival karst*.

alternative. Adjective used to designate an intake or resurgence operating only during rainy seasons; in some areas reversible; equivalent to *intermittent*. Also used as a noun^[10].

alveolar. 1. Consisting of a honeycomb shape^[16]. 2. A specific erosional pattern resulting in a cellular structure^[16]. See also *alveolization*.

alveolization. (From the Latin word “alveolatus,” meaning hollowed out.) Pitting of a rock surface produced by wind loaded with sand, by water charged with carbonic acid, or by plant roots^[10]. See also *alveolar*. Synonyms: (French.) *alvéolisation*; (German.) *Aeolisation* *Wabenverwitterung*; (Greek.) *kypselothis epiphania*; (Italian.) *alveolizzazione*; (Spanish.) *alveolización*; (Turkish.) *çukurlaşma*; (Yugoslavian.) *alveolizacija*.

ammeter. A meter used to measure the flow of water in a stream channel. Synonym: *current meter*^[16].

amorphous silica. Silica with no definite crystalline structure^[16].

analysis, chemical. Laboratory procedure in water quality determination to identify chemical constituents^[16].

analysis, complete chemical analysis. Chemical analysis of a water sample for physical, chemical, and bacteriological constituents^[16].

analysis, core. Petrophysical analysis of a rock core acquired through the process of

boring a hole in rock with the intention of producing a core of rock as opposed to chips^[16].

analysis, morphometric. A geodetic and geometric description of basin, stream network, or sinkhole plain, the purpose of which is to determine the frequency and hierarchy of occurrences^[16].

analysis, sieve. Mechanical grain size analysis by sieving an unconsolidated material through a series of sieves^[16].

anastomosis. 1. The development of a network of branching, intersecting, and rejoining channels in a two-dimensional system. Anastomosing tubes, or cave anastomoses, which are generally formed due to dissolution by slow, poorly directed phreatic flow along a bedding-plane parting or fracture in limestone, represent an important element in the early stages of cave development. Individual anastomoses most commonly have a diameter of approximately 100 mm, and networks may contain hundreds of tubes. Most anastomoses are abandoned when one channel offers preferential flow conditions so that it increases in size at the expense of others. Such abandoned or relict anastomoses are commonly exposed only by subsequent wall or roof collapse^[32]. 2. A network of tubular passages or holes in a cave or in solution-sculptured rock. A complex of many irregular and repeatedly connected passages^[9, 21]. Synonym: *labyrinth*; (French.) *anastomose*; (German.) *Labyrinth*; (Greek.) *anastomosis*; (Italian.) *anastomosi*; (Russian.) *labirint*; (Spanish.) *anastomosis*; (Turkish.) *geçit şebekesi*; (Yugoslavian.) *splet kanala*.

anastomotic cave pattern. A type of maze cave consisting of tubular passages or holes in a cave or in a solution-sculptured rock. A complex of many irregular and repeatedly connected passages. Synonym: *labyrinth*.

anchor ice, ground ice. Ice that is temporarily attached to the bottom of a river^[16].

anemolite. A helictite in which the eccentricity is ascribed to the action of air currents^[10]. The word is derived from wind-control theory of helictite formation^[9].

anemometer. A device used to measure wind speeds^[16].

angle of contact, wetting angle. The angle between the liquid phase and solid boundary measured through the liquid phase^[16].

angle of repose. The natural slope of unsupported granular material^[16].

anglesite. A cave mineral — PbSO_4 ^[11].

angular. The property of unconsolidated grains with sharp edges^[16].

angular unconformity. A geological unconformity with marked difference in dip of the superimposed series^[16].

anhydride. Anhydrous calcium sulfate, CaSO_4 ^[16].

anion. A negatively charged ion that migrates to an anode, as in electrolysis^[6].

anion exchange. Ion exchange process in which anions in solution are exchanged for other anions from an ion exchanger^[6].

anisotropic. The property of aquifer systems displaying different hydrological properties in different directions^[16]. See also *anisotropy*; *anisotropic mass*.

anisotropic mass. A mass having different properties in different directions at any given point^[22].

anisotropic steering. Anisotropic structures (anisotropies) in rock, such as schistosity, inclusions, and fractures, which can deviate or “steer” the direction of fractures subsequently developed.

anisotropy. The condition of having different properties in different directions^[22].

annual frost zone. The top layer of ground subject to annual freezing and thawing^[16].

annual mean. The mean value taken over all events that have occurred during a year, such as precipitation, river stages, or water-table levels^[16].

annulus. The annular space between drill pipe and casing or between casing and the borehole wall^[16].

anomaly. The deviation from normally expected findings, especially in exploration geophysics, indicating a change in subsurface environmental conditions^[16].

antecedent precipitation index. A precipitation index that is based on the amount of previous precipitations^[16].

antecedent-soil moisture. The degree of water saturation in the soil prior to a precipitation event^[16].

antecedent stream. A stream having established its course before occurrence of orogenic events that would later alter the general drainage pattern^[16].

anthodite. 1. Radiating crystals of aragonite, mostly sharp needles 1-20 mm long. They occur sporadically in some caves but may also be spectacularly abundant, with clean white crystals growing all over the rock and calcite surfaces. Carlsbad Caverns (USA) and Grotte de Moulis (France) have fine anthodite displays^[9]. 2. A cave formation composed of feathery or radiating masses of long needlelike crystals of gypsum or aragonite, which radiate outward from a common base^[10]. See also *cave flower*.

anthropocentric definitions. Definitions of caves or parts of caves that include accessibility by human explorers as one of their limiting conditions. Most well known among these is the definition published by the International Speleological Union, that “A cave is a natural underground opening in rock that is large enough for human entry” (see *proto-caves*)^[9].

anticlinal valley. A valley that is established along the axis of an eroded anticline^[16].

anticline. Upfolded stratum^[16].

aphthitalite. A cave mineral — $(K,Na)_3Na(SO_4)_2$ ^[11].

apparent ground-water velocity. See *specific discharge*.

approach segment. That part of a hydrograph curve before onset of precipitation^[16]. See also *hydrograph*.

apron. A smooth bulging mass of flowstone covering sloping projections from walls of caves or limestone cliffs^[10].

aqueduct. A conduit to convey water, usually above ground^[16].

aquiclude. A formation which, although porous and capable of storing water, does not transmit it at rates sufficient to furnish an appreciable supply for a well or spring. See also *confining unit*^[22].

aquifer. 1. A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs^[6]. 2. A ground-water reservoir. 3. Pervious rock that is completely saturated and will yield water to a well or spring. Historically the term has been applied to beds favoring early cave development, probably synonymous with some inception horizons^[18].

aquifer, artesian. A confined aquifer where the potentiometric surface rises above the top of the aquifer bed^[16].

aquifer, coastal. An aquifer in a coastal region open to salt-water intrusions^[16].

aquifer, flowing artesian. An artesian aquifer in which the water, under hydrostatic pressure, rises above the land surface.

aquifer, karst. An aquifer in which the flow of water is or can be appreciable through

one or more of the following: joints, faults, bedding-plane partings, and cavities, any or all of which have been enlarged by dissolution^[18].

aquifer, leaky. An aquifer overlain or underlain by semipermeable strata from or into which water will flow^[16].

aquifer stimulation. A type of development that is done in semiconsolidated and completely consolidated formations to alter the formation physically to improve its hydraulic properties^[6].

aquifer storage. Gas storage in an aquifer^[16].

aquifer system. A body of permeable and poorly permeable material that functions regionally as a water-yielding unit; it comprises two or more permeable beds separated at least locally by confining beds that impede ground-water movement but do not greatly affect the regional hydraulic continuity of the system; includes both saturated and unsaturated parts of permeable material^[22].

aquifer test. A test to determine hydrologic properties of the aquifer involving the withdrawal of measured quantities of water from or addition of water to a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or additions^[6].

aquifere epikarstique. See *epikarst zone*.

aquifuge. A formation that has no interconnected openings or interstices and therefore neither stores nor transmits water^[22]. See also *confining unit*.

aquitard. A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer; a leaky confining bed. It does not readily yield water to wells or springs, but may serve as a storage unit for ground water^[22]. See also *confining unit*.

aragonite. 1. A relatively rare form of calcium carbonate (CaCO_3), chemically identical to the more common calcite but of orthorhombic crystal form. Its pure form is metastable in the cave environment, where calcite forms preferentially. It is relatively abundant in some caves owing to the presence of impurities, notably strontium, that distort the carbonate lattice and favor aragonite growth. The commonest form seen in caves is small radiating crystals (anthodites) that develop in humid caves, where surfaces are covered by a moisture film but not by flowing water. 2. A mineral composed of calcium carbonate, CaCO_3 , like calcite but differing in crystal form^[10]. 3. An unstable orthorhombic carbonate mineral, CaCO_3 ^[16].

ardealite. A cave mineral — $\text{Ca}_2(\text{SO}_4)(\text{HPO}_4)\cdot 4\text{H}_2\text{O}$ ^[11].

area of influence of a well. The area surrounding a pumping or recharging well within which the potentiometric surface has been changed^[22].

arête and pinnacle karst. A landscape of naked reticulated raw-topped ridges having almost vertical slopes and a relief of as much as 120 meters. The ridges rise above forest-covered corridors and depressions. Found in New Guinea at elevations of 2,000 meters and more^[10]. Both pinnacle karst and arête karst are varieties of limestone

landscape formed under equatorial rain forest cover. They are characterized by vertical-sided blades of bare rock fretted by dissolution^[9].

argillaceous. The property of rocks containing clay in non-negligible proportions^[16].

argillaceous limestone. Limestone containing considerable amounts of clay^[16].

arid. The property of dry climates and regions with a net deficiency of moisture^[16].

arrival time. 1. In subsurface flow tracing, the time for the first tracer pulse to arrive at a discharge location. 2. In geophysics, the time of arrival for the first seismic wave to arrive at a geophone^[16].

artesian. Synonymous with *confined*.

artesian aquifer. Synonymous with *confined aquifer*. See *aquifer*, *artesian*.

artesian flow. Flow through a confined aquifer where the elevation of the overlying aquiclude is locally depressed so that the entire aquifer is saturated and the flow is under hydrostatic pressure. Some maze cave development in cavernous limestones may be due to artesian flow, which is commonly related to synclinal fold structures^[9].

artesian spring. See *spring*, *artesian*.

artesian well. A well deriving its water from a confined aquifer in which the water level stands above the ground surface^[6]. Synonym: *flowing artesian well*.

artificial discharge. The discharge of ground water by pumping wells^[16].

artificial recharge. Recharge at a rate greater than natural, resulting from deliberate or incidental human activities^[6].

ascender. A mechanical device, used by cavers who are ascending or descending through a vertical opening in a cave (e.g., vadose shaft), that uses a cam to grip a rope while downward pressure is being applied to the device^[13]. See also *mechanical ascender*; *prusiking*; *prusik knot*.

atmometer. An instrument used to measure evaporation intensities^[16].

atmosphere. A gaseous envelope of the earth that contains and transports air and water in vapor and condensed form^[16].

attapulgitic clay. A colloidal, viscosity-building clay consisting of hydrous magnesium aluminum silicates and used principally in salt-water drilling fluids^[6].

attrition. The wearing away of rocks by friction^[16].

auger. A rotary drilling device where the dry cuttings are removed continuously by helical grooves on the drill pipe^[16].

aurichalcite. A cave mineral — $(\text{Zn,Cu})_5(\text{CO}_3)_2(\text{OH})_6$.

autochthonous. Property pertaining to sedimentary material originating and deposited at about the same location^[16]. See also *allochthonous*.

autochthonous drainage. Less common synonym for *autogenic drainage*^[9].

autogenic, authigenic. Formed or generated in place^[1]. See also *allogenic; recharge, autogenic; recharge, allogenic*.

autogenic drainage. Underground karst drainage that is derived entirely from absorption of meteoric water into the karst rock surface^[9]. Synonym: *autochthonous drainage*. See also *allogenic drainage*.

available water. The water available to plants in the soil zone as defined by the interval between field capacity and wilting point^[16].

aven. 1. A hole in the roof of a cave passage that may be either a rather large blind roof pocket or a tributary inlet shaft into the cave system. A feature described as an aven when seen from below may equally be described as a shaft when seen from above, and the naming of such a feature commonly depends purely upon the direction of exploration. Many avens close upwards to impenetrable fissures but may still be important hydrological routes; few caves are without them. In parts of France, aven is equivalent to the British term *pothole*^[9]. 2. (French.) A vertical or highly inclined shaft in limestone, extending upward from a cave passage, generally to the surface; smaller than an abîme. Commonly related to enlarged vertical joints. Compare *cenote; natural well; pothole*. 3. (British.) A vertical extension from a shaft in a passage or chamber roof that tapers upward rather like a very elongated cone^[10]. Compare *dome pit*.

average interstitial velocity. See *velocity, average interstitial*.

azonal soil. Soils without distinct layering in horizons^[16].

azurite. A cave mineral — $\text{Cu}(\text{CO}_3)_2(\text{OH})_2$ ^[11].

B

backflooding. 1. Temporarily rising water level in a cave caused by a downstream passage being too small to pass an abnormally high discharge. The excavation and reexcavation of some caves is ascribed to the enlargement of a passage at or near the water table by gravity flow alternating with periods of calcite precipitation^[10]. 2. Flooding due to backup of excess flow behind a constriction in a major conduit. Water that is ponded in tributary passages and proto-caves upstream of the constriction may contribute to the enlargement of maze caves^[9].

background noise. The level of intensity of signals due to normal activities other than the specific signal emission^[16].

backwater. The accumulated water above the normal level of a water course due to impoundment at a point downstream^[16].

backwater curve. Water surface profile in a stream or channel above a constriction or impoundment^[16].

bacon. Thin, elongated, translucent flowstone having parallel colored bands on or projecting from roofs and walls of some caves^[10]. See also *blanket*; *curtain*; *drapery*.

bactericide. A substance used to destroy bacteria (e.g., iron bacteria)^[6].

bailer. 1. A cylindrical container used to withdraw a sample of water from a well. 2. A cylindrical container with a bottom valve for the clearing of drill cuttings from the bottom of a borehole^[16].

bailing line. Cable operating a bailer^[16].
Synonym: *sand line*.

balcony. Any projection on the wall of a cave large enough to support one or more persons^[10].

bank. Ascending slope bordering a river^[16].

bank erosion. Erosion of a river bank^[16].

bank storage. 1. Subsurface conduit water that has been driven back up into older, higher karst levels and into the surrounding rock matrix during a high flow period. 2. River water that has infiltrated river banks during a high flow period and been retained in temporary storage^[16].

bare karst. A type of karst landscape lacking soil cover and where dissolution of carbonate rocks to form karst landforms occurs primarily on the exposed bedrock surface^[9]. See *naked karst*.

barite. 1. A cave mineral — BaSO₄. 2. A natural finely ground barium sulfate used for increasing the density of drilling fluids^[6].

barograph. A pressure recorder^[16].

barometer. An indicator of barometric pressure^[16].

barometric efficiency. The ratio of water level change to atmospheric pressure change in a well^[16].

barrier. A geological formation or part of a formation having become impervious to ground-water flow because of a facies change^[16].

barrier, freshwater. Barrier of freshwater injected into an aquifer to stop the inflow of seawater into a coastal aquifer^[16].

barrier, hydrologic. Lithologic formation preventing horizontal movement of ground water^[16].

barrier, permeability. A geologic or petrographic feature in a bed obstructing free flow^[16].

barrier spring. See *spring, barrier*.

base exchange. The displacement of a cation bound to a site on the surface of a solid, as in silica-alumina clay-mineral packets, by a cation solution^[6].

base flow. 1. That part of the stream discharge that is not attributable to direct runoff from precipitation or melting snow; it is usually sustained by ground-water discharge^[22]. 2. Sustained fair-weather runoff^[16].

base level. Lowest level of erosion by a stream^[16].

base level of erosion. The lowest theoretical level of surface to be achieved by erosion^[16].

base level, karst. See *karst base level*.

base line. 1. An arbitrary line from which deflections of self potential are read^[16]. 2. Shale line^[16].

baseline monitoring. The establishment and operation of a designed surveillance system for continuous or periodic measurements and recording of existing and changing

conditions that will be compared with future observations^[22].

base of karstification. Level below which karstification has not occurred. See also *karst base level*.

base width. The width of the hydrograph as determined by a line parallel to the time axis cutting through the points where the rising limb starts and where the recession curve ends^[16].

basin. Hydrogeographic unit receiving precipitation and discharging runoff in one point^[16].

basin characteristics. The physiographic, geologic, and ecologic characteristics of a basin^[16].

basin, closed. Drainage basin with no surface flow outlet^[16].

basin, drainage. The area contributing to runoff which sustains streamflow^[16]. See also *drainage basin*.

basin, experimental. A basin chosen for the thorough study of hydrological phenomena^[16].

basin, ground-water. The area throughout which ground water drains towards the same point. It can be larger than the associated drainage basin if permeable layers extend outside of the topographical divide^[16]. In karst terranes, the ground-water basin often does not resemble the drainage basin.

basin, infiltration. Basin in which water is spread for recharge^[16].

basin, intermontane. A basin lying between two mountain ranges^[16].

basin method. A recharge method in which water is spread in shallow basins^[16].

basin mouth. The point at which runoff leaves a basin^[16].

basin perimeter. The circumference of a basin following the divide^[16].

basin relief, maximum. The elevation difference between basin mouth and the highest point within a basin perimeter^[16].

basin, settling. A basin used for the settling out of solids from suspension^[16].

bathypneustic zone. See *phreas*.

bathometer. An instrument for measuring water depths in wells^[16].

beach. A shore consisting of sand or gravel deposits^[16].

beachrock. 1. Rock composed of sand grains and/or sand-sized shell fragments cemented by calcium carbonate, commonly formed very rapidly on some beaches in tropical and subtropical areas. Beachrock generally occurs as thin beds between bedding planes that dip seawards at angles similar to those of the beach slope^[9]. 2. A friable to indurated rock consisting of sand grains of various minerals cemented by calcium carbonate; occurs in thin beds dipping seaward at less than 15°. Also known as beach sandstone^[10].

bed. 1. A layer in sedimentary rocks; a stratum^[10]. 2. A sedimentary deposit of

relatively small thickness and great areal extent, separated by bedding planes from over- and underlying deposits^[16].

bed load. See *bedload*.

bed, lower confining. An impermeable bed underlying an aquifer^[16].

bed, marker. Bed with characteristic features that can be followed over large areas for identification purposes^[16].

bed, mortar. Secondary calcium carbonate cementations in the lower part of a soil profile^[16]. Synonym: *hardpan*.

bed, river. The channel of a river covered by water^[16].

bed roughness. The roughness of a channel or river bed^[16].

bed, stream. The bottom of a stream covered by water^[16].

bed, upper confining. Impermeable bed overlying an aquifer^[16].

bedding. Applies to rocks resulting from consolidation of sediments and exhibiting surfaces of separation (bedding planes) between layers of the same or different materials (e.g., shale, sandstone, limestone, etc).

bedding cave. See *bedding-plane cave*.

bedding grike. Term used to describe the occurrence of the dissolution and widening (similar to that which occurs in joints) of nearly vertical bedding in karst terranes^[8]. Synonym: (German.) *Schichtfugenkarren*.

bedding joint. A joint in rocks that runs parallel to or on a bedding plane^[16].

bedding plane. 1. A primary depositional lamination in sedimentary rocks that may be preserved, though possibly with different properties, in metamorphic rocks. These laminations may be clearly visible where lithologies change or where depositional cycles were completed/initiated, or they may be effectively invisible to the naked eye, marking subtle changes in depositional conditions. Most bedding planes were originally horizontal or very slightly inclined, but more steeply inclined bedding planes developed in rocks deposited in deltaic or sand dune environments or in marine reefs. When rocks are folded the bedding planes provide an indication of the degree of deformation. Bedding planes play a crucial role in the inception and ongoing development of most caves and many surface karst features^[3]. 2. A plane that separates two strata of differing characteristics^[10]. See also *parting*.

bedding-plane cave. 1. Bedding planes are widespread and very significant features within most carbonate rocks, and cave passages are commonly guided by them. Their structure, their distribution, and the chemical contrasts that some bedding planes provide may be the major influence during the earliest phases of development of a cave system. The term bedding-plane cave is strictly applied to a passage that has not enlarged by growth into a major tube or canyon, but has remained almost entirely on the bedding plane. A famous example is Hensler's Passage, in Gaping Gill, Yorkshire, which is over 400 m long, nearly 5 m wide and nowhere higher than 1 m^[9]. 2. A passage formed along a bedding plane,

especially when there is a difference in susceptibility to corrosion in the two beds^[10]. 3. A cave whose location is controlled by the bedding of the enclosing formation or formations^[20]. Synonyms: (French.) *grotte de stratification*; (German.) *schichtgebundene Höhle*; (Greek.) *strosigenes speleon*; (Italian.) *grotta di interstrato*; (Russian.) *pescera v ploakosti naplastovanija*; (Spanish.) *cueva adaptada a planos de estratificación*; (Turkish.) *tabakalanma mağarası*; (Yugoslavian.) *slojna pečina*.

bedding-plane parting. See *bedding plane* and *parting*.

bedeckter karst. See *covered karst*.

bedload. The part of the total stream load that is moved on or immediately above the stream bed, such as the larger or heavier particles (boulders, pebbles, gravel) transported by traction or saltation along the bottom; the part of the load that is not continuously in suspension or solution^[6].

bedrock. Solid rock underlying unconsolidated material^[16].

bench mark. A relatively permanent mark, natural or artificial, furnishing a survey point at a known elevation in relation to an adopted datum^[16]. Bench marks, or marked points, connected by precise leveling, constitute the control of land-surface settlement in subsidence studies^[21].

bend. Curve in a water course^[16].

bentonite. A colloidal clay, largely made up of the mineral sodium montmorillonite, a hydrated aluminum silicate^[6].

B-horizon. Illuvial horizon in which soluble material from the overlying A-horizon has been deposited^[16].

belay. A safety rope tied around a caver that is played out or taken in by a second person as the caver moves. The purpose of the belay is to prevent the caver from falling more than a few feet^[13].

beudantite. A cave mineral — $\text{PbFe}_3(\text{AsO}_4)(\text{SO}_4)(\text{OH})_6$ ^[11].

bicarbonate. A salt containing the radical HCO_3^{-1} , such as $\text{Ca}(\text{HCO}_3)_2$ ^[10].

bifurcation. The forklike separation of a water course into two arms^[16].

bifurcation ratio. The ratio of the number of stream segments of a given order to the number of segments of next higher order^[16].

biomicrite. A microscopic-textured limestone composed of skeletal grains in a matrix of micrite; micrite is a finely crystalline carbonate sediment with the upper crystalline diameter being 4 microns^[20]. Synonyms: (French.) *biomicrite*; (German.) *Biomicrite*; (Greek.) *micrite*; (Italian.) *biomicrite*; (Spanish.) *biomicrita*; (Turkish.) *biyomikrit*; (Yugoslavian.) *biomikrit*. See also *micrite*; *peloid*.

biospeleology. The study of subterranean living organisms, particularly in karst caves and other openings in rock formations^[9, 21]. Synonyms: (French.) *biospéléologie*, *biospéologie*; (German.) *Biospeläologie*; (Greek.) *biospeleology*; (Italian.) *biospeleogia*; (Russian.) *biospeleologija*; (Spanish.) *biospeleología*; (Turkish.)

biyospeleoloji, *mağara canlıları bilimi*; (Yugoslavian.) *biospeleologija*.

biphosphammite. A cave mineral — $\text{NH}_4\text{H}_2\text{PO}_4$ ^[11].

birnessite. A cave mineral — $(\text{Na,Ca})\text{Mn}_7\text{O}_{14}\cdot 3\text{H}_2\text{O}$ ^[11].

blade. In a cave, a thin sharp projection jutting out from roof, wall, or floor, of which it is an integral part; generally the remains of a partition or bridge^[10].

blanket. A thick layer of dripstone, not translucent^[10]. See also *bacon*; *curtain*; *drapery*.

blind chimney. See *chimney*.

blind valley. 1. A karst valley abruptly terminated by the passage underground of a watercourse that has hitherto resisted the karst processes and remained at the surface. An intermediate type, the *half-blind valley*, exists in which the valley form continues downstream from the sinkhole used under conditions of normal river flow. The watercourse only flows here intermittently and the valley may (except for its use as a flood conduit) be fossil in that it represents the section abandoned by the river as it sought progressively higher swallow holes^[19]. 2. A karst valley with no evident downstream continuation, and one in which the water drains and disappears underground into one or more ponors^[20]. 3. A valley that terminates abruptly at a point where its stream sinks, or once sank, underground. As sinks develop higher up the blind valley, the original valley termination may be dry under most flow conditions^[9]. Related to *marginal polje*.

Synonyms: (French.) *vallée aveugle*; (German.) *Blindtal (Kesseltal)*; (Greek.) *kliste karstike kilas*; (Italian.) *valle cieca, valle chiusa*; (Russian.) *slepaja dolina*; (Spanish.) *valle ciego*; (Turkish.) *kör vadi*; (Yugoslavian.) *slijepa dolina, sepa dolina*. See also *half-blind valley*; *marginal polje*.

bloedite. A cave mineral — $\text{Na}_2\text{Mg}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ ^[11].

blowhole. 1. Opening in the roof of a cave or cavern through which air is expelled vigorously. In coastal areas the phenomenon is usually due to compression of air within the cave by incoming tides or waves^[20]. 2. Cliff-top entrance to a sea cave, also known as a *geo*, *gloop*, or *gloup*^[9]. 3. (Australian.) A small hole in the surface of the Nullarbor Plain through which air blows in and out with observable force, sometimes audibly^[10]. Related to *breathing hole*. Synonyms: (French.) *trou souffleur*; (German.) *Windhöhle*; (Greek.) *ope ekphysosa*; (Italian.) *bocca soffiante*; (Spanish.) *soplador*; (Turkish.) *üflenme ağzı*; (Yugoslavian.) *vjetrenica, veternica, puhaljka, pihalnik, dihalnik*. See also *steam hole*.

blowing cave. A cave out of which or into which a current of air flows intermittently^[10].

blowing well. A well or borehole into which air is sucked and from which air is blown (often with considerable velocity) because of changes in barometric pressure or in water level. The phenomenon indicates that the well or borehole is in communication with an underground air-filled cavity. Synonyms: (French.) *puits souffleur*; (German.) *Windkamin*; (Greek.) *ekphysosa*

ope; (Italian.) *pozzo soffiante*; (Russian.) *dujuščij kolokec*; (Spanish.) *sondeo soplador*; (Turkish.) *üfleç kuyu*. See also *steam hole*.

blowout. An uncontrolled escape of drilling fluid, gas, oil, or water from a well caused by the formation pressure being greater than the hydrostatic head of the fluid in the hole^[6].

blue hole. 1. Deep resurgence pool, notably in Jamaica and Florida, that may have a blue color due to the presence of algae. Also, a deep submarine cave of the Bahamas. The latter type are large flooded shafts cut into the limestones of the shallow reefs and lagoon floors. Many are 100 m in diameter and some are 100 m deep. Opening from the shafts are flooded cave passages at various depths, some of which have been explored subhorizontally for more than 1 km. Their origins are complex. Extensive stalagmite deposits show that large old caves were drained when sea levels were low during the Pleistocene (when water was held in ice sheets). They are now being modified by marine dissolution, notably at the interface between fresh and salt waters (sea littoral zone) and by powerful tidal flows between connected holes^[9]. 2. (Jamaican.) A major emergence where water (artesian spring) rises from below without great turbulence. 3. (Bahamas.) A drowned solution sinkhole^[10]. 4. Caribbean expression for a major quiet up-welling karst spring inland or along the coast. The blue color is due to the scattering of sunlight by water molecules, although in some cases it may be attributed to the presence of calcareous algae^[20]. Synonyms: (French.) *source bleue* (Jura), *bleu-fon* (South of France); (German.) *Blaue Grotto*;

(Greek.) *galapo speleo*. See also *boiling spring*.

Bodenbedeckter karst. See *subsoil karst*.

bog. Swamp^[16].

bogaz. 1. (Slavic.) An elongated depression in limestone or karst terrain; thus it embraces a defile, a blind valley, or a ravine leading to a ponor. It can be considered as a giant grike. This meaning is based on the Serbian use^[20]. 2. A variable-discharge artesian spring in which hydrostatic pressure is great enough to cause a turbulent or even fountain-like discharge. 3. A long narrow chasm enlarged by solution of the limestone^[10]. 4. Large linear fissure or box valley through a karst block. Effectively a giant grike, perhaps 50 m deep and 1 km long, formed by dissolution on a fault or joint in very massive limestone^[9]. Synonyms: (French.) *défilé*, *bogaz*; (German.) *Doline*, *Karstgasse*, *Blindtal*, *Zangön*; (Greek.) *faragothis doline*; (Spanish.) *zanjón*; (Turkish.) *bog ˘az*; (Yugoslavia.) *bogaz*. See also *canyon*; *gorge*; *grike*; *corridor*; *struga*; *zanjón*.

boiling spring. See *spring*, *boiling*.

bone-breccia. Cave breccia including much bone^[10].

bone cave. A cave recognized particularly for its contained deposits of animal bones. The bones may be the remains of animals that fell into the cave, as in the Joint Mitnor Cave, Devon, or in many other pitfall or fissure sites. Alternatively the bones may be of animals that originally lived in the cave - and these may include man, as at Niah Cave, Sarawak, or at Russell Cave,

USA. A third, and most important, type of bone cave is the ancient animal den, into which scavengers such as hyaenas dragged the remains of many other animals, as for example at Kirkdale Cave in North Yorkshire^[3].

borehole. 1. Boring into unconsolidated and consolidated materials for the purpose of subsurface hydrogeological investigations. 2. Synonym for a well-developed phreatic tube passage^[9].

botryoid, botryoidal speleothem. 1. Generally sub-spherical or globular calcium carbonate deposits ranging in size between tiny beads and masses up to 1 m across. Botryoidal describes a form resembling a bunch of grapes^[9]. 2. A grapelike deposit of calcium carbonate generally found on walls of caves^[10]. Synonyms: *clusterite*; *grape formation*. See *coralloid speleothem*.

bottom hole. The lowest part of a drilled hole where the drilling bit cuts into the rock^[16].

bottomland. A lowland along an alluvial river plain^[16].

boulder clay. See *glacial till*.

boundary spring. See *spring*, *boundary*.

bourne. (British.) 1. A stream that appears in a normally dry valley, particularly on the Chalk outcrop in southern England, during wet conditions^[9]. 2. Intermittent stream in a normally dry valley in chalk country^[10].

boxwork. 1. A three-dimensional network of thin sheets of mineral projecting from a cave wall. The boxwork is vein fillings

etched from the cave wall by dissolution of the host limestone and consists mostly of calcite and quartz. It is not common, but spectacular displays occur in Wind Cave, South Dakota, USA^[9]. 2. Network of thin blades of calcite or gypsum etched out in relief on the limestone walls and ceiling of a cave^[10].

brackish water. Water containing from 1000 to 10,000 ppm of total dissolved solids^[16].

braided stream. A stream that divides into or follows an interlacing or tangled network of several small branching and reuniting shallow channels separated from each other by branch islands or channel bars, resembling in plan the strands of a complex braid^[6].

brake bar. A round bar approximately 2½ x ¾ inches that is placed on rappel racks or carabiners so that rope can be threaded through the rack or carabiners for rappelling^[13].

branchwork cave pattern. 1. A cave system that has been formed by the intersection of tubular or canyonlike conduits as tributaries in the downflow direction. 2. A dendritic cave system of subterranean watercourses having many incoming branches and no visible outgoing ones^[10].

breakdown. See *cave breakdown*.

breakthrough. A quantum jump in erosional activity that is associated with the transition from dominantly laminar to dominantly turbulent flow conditions^[9]. See turbulent threshold.

breakthrough curve. 1. A plot of relative concentration versus time, where relative concentration is defined as C/C_0 with C as the concentration at a point in the groundwater flow domain and C_0 as the source concentration^[22]. 2. A plot of tracer concentration, C , versus time, t , for a groundwater tracing study in karst conduit for the purpose of quantitatively determining how much tracer mass was recovered, mean time of travel, mean tracer flow velocity, and related hydraulic flow and geometric parameters. Synonyms: *recovery curve*; *tracer-breakthrough curve*; *tracer-recovery curve*.

breakthrough time. The time required to develop a conduit large enough (usually 5-10 mm in diameter) to support turbulent flow^[9].

breathing cave. Air movement through a cave is described as breathing when it reverses more frequently than the seasonal reversal of a through-draught in a cave with higher and lower entrances. Slow breathing occurs in response to barometric pressure changes when the volume of cave air is forced to change. It is notoriously strong in large caves of the Australian Nullarbor Plain. More rapid wind reversals or oscillations, as in Breathing Cave, Virginia, are a resonance phenomenon, similar to the effect produced by air passing over the neck of a bottle. In the cave environment the resonant frequency is relatively low and periodic air flow reversals occur, rather than the sound waves observed at the higher frequencies met in the bottleneck example^[9].

breathing hole. Opening in the roof of a cave, cavern, or other underground void

through which air is sucked in and expelled in a rhythmic manner similar to inhalation and exhalation of breath^[20]. Related to *blow hole* and *steam hole*. Synonyms: (French.) *trou souffleur*; (German.) *Luftloch*; (Greek.) *anapnéousa opí spiléou*; (Spanish.) *respirador*; (Turkish.) *esintili delik*.

breccia. 1. Angular fragments of rock, commonly but not inevitably cemented by finer-grained materials including silica, iron minerals, and calcite to form a new rock. Many fault planes are marked by zones of broken rock, either loose or re-cemented, forming a fault breccia^[9]. 2. Rock composed of angular fragments^[16].

bridge. 1. May be a natural bridge of bedrock normally formed outside a cave entrance by partial collapse leaving an isolated roof segment, as in the famous examples of Rakov Škocjan, Slovenia. Rock bridges may also occur inside caves through either surrounding phreatic dissolution or collapse between superimposed passages. Another common type inside a cave is a span of false floor where sediment is washed from below, as at The Bridge in GB Cavern in the Mendip Hills^[9]. 2. In a cave, a residual rock span across a passage^[10]. 3. In water wells, an obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by filter pack materials during well completion. Bridging can also occur in the formation during well development^[16]. See also *natural bridge*.

bridging effect. The forming of arches in a packing of materials^[16].

brine. Water containing more than 100,000 ppm of total dissolved solids^[16].

brittle deformation. The sudden failure of a rock with complete loss of cohesion across a plane.

brochantite. A cave mineral — $\text{Cu}_4(\text{SO}_4)(\text{OH})_6$ ^[11].

brushite. A cave mineral — $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ ^[11].

bubble gage. A stage recorder based on the principle of equating a gas pressure to water level^[16].

bucket. A measuring reservoir in liquid gaging instruments^[16].

buffered solution. A solution that resists changes in the pH value upon addition of acids or bases^[16].

buildup. The vertical distance the water table or potentiometric surface is raised, or the increase of the pressure head due to the addition of water^[22].

buried karst. Karst topography entirely buried by relatively younger post-rock or sediments and not part of the contemporary landscape^[17]. Synonyms: *fossil karst*; (French.) *karst couvert*, *karst fossile*, *paleokarst*; (German.) *bedeckter Karst*, *Urkarst*; (Greek.) *kaymeno paleokarst*; (Italian.) *carso sepolto*; (Spanish.) *karst soterrado*; (Turkish.) *gömülü karst*; (Yugoslavian.) *pokriveni krš* See also *covered karst*; *paleokarst*; *subsoil karst*.

buried valley. An ancient valley buried by recent, often glacial deposits^[16].

burst. 1. Periods of heavy rainfall^[16]. 2. An explosive breaking of brittle rock material (e.g., rock burst in a deep mine tunnel).

C

caballing. The mixing of two water masses to produce a blend that sinks because it is denser than its original components. This occurs when two water masses have the same density but different temperatures and salinities.

cable ladder. A ladder used in vertical caving that is made of two parallel cables with metal rungs held in place with metal tubes crimped to the cables^[13].

cable way. A cable stretched across a river from which a cable car is suspended to allow for stream discharge measurements^[16].

caisson. A protective chamber for the excavation of water-submerged unconsolidated sediments^[16].

calanque. (French.) 1. Cove or small bay. 2. A valley excavated in limestone or formed by collapse of the roof of a cave and subsequently submerged by a rise in sea level^[10].

calc-. Prefix meaning “limy”; containing calcium carbonate^[10].

calcarenite. 1. Limestone or dolomite composed of coral or shell sand or of grains derived from the disintegration and erosion of older limestones. Size of particles ranges from 1/16 to 2 millimeters^[10]. 2. A carbonate rock that consists predominantly (>50%) of sand-sized calcite (or dolomite) particles. Many of the particles are the angular or degraded fragments of fossil shells^[9].

calcareous. 1. Containing calcium carbonate^[10]. 2. Descriptive of a rock that contains calcium carbonate^[9].

calcareous tufa. See *sinter*.

calcification. Replacement of the original hard parts of an animal or plant by calcium carbonate^[10].

calcilutite. 1. Clastic limestone or dolomite in which the grains have an average diameter of less than 1/16 millimeter; calcareous mudstone^[10]. 2. A carbonate rock that consists predominantly (>50%) of silt and/or clay size calcite (or dolomite) particles^[9].

calcirudite. A fragmental limestone in which the particles are generally larger than 2 millimeters^[10].

calcite. 1. The commoner, more stable mineral form of calcium carbonate, CaCO_3 . It is the dominant component of all limestones and, owing to its dissolution and reprecipitation by natural waters at normal temperatures, it is also the dominant mineral of chemical cave deposits, including stalactites and stalagmites. It is white or colorless when pure but may be stained, most commonly to yellows and browns, by included impurities such as iron oxides. Its uninterrupted growth in a pool may allow development of good crystals, shaped as elongate scalenohedral pyramids of trigonal habit. Growth in stalactites and stalagmites is either in masses of fine parallel or radiating needles, or in a mosaic of larger rhombic crystals, easily identified by their well-developed cleavage surfaces. Calcite is also the dominant vein mineral in limestones^[9]. 2. A mineral composed of

calcium carbonate (CaCO_3), like aragonite but differing in crystal form; the principal constituent of limestone and other speleothems^[10].

calcite bubble. A hollow sphere formed by the deposition of calcite around a gas bubble; the interior is smooth and the exterior consists of small jagged crystals^[10].

calcite flottante. (French.) See *floe calcite*.

calcite raft. A veneer of reprecipitated calcite forming a sheet over all or part of the surface of a static cave pool in conditions favoring the release of carbon dioxide^[19].

calc-sinter. See *sinter*.

calcium carbonate. Naturally occurring compound with the chemical formula CaCO_3 . It occurs commonly as the mineral calcite and less commonly as aragonite, and is the major component of carbonate rocks including limestone and marble. It also forms the matrix or cement that holds together many sandstones and other sedimentary rocks^[9]. See also *dolomite*.

calcrete. (South African.) See *caliche*.

calibration. The experimental evaluation of the scale readings of an instrument against an absolute standard^[16].

caliche. 1. (Chilean and Peruvian.) A natural deposit of nitrates and other salts precipitated at the soil surface. 2. (Mexico and Southwestern United States.) Indurated calcium carbonate and other salts found in the soil at the surface in arid and semiarid regions, generally formed by evaporation of lime-bearing waters drawn to the surface by

capillary action. 3. In some areas, refers to hardpan resulting from concentration of carbonate in the soil by downward leaching and reprecipitation^[10]. 4. A deposit of precipitated minerals, mainly calcite or gypsum or both, formed in the soil or near-surface layers in arid and semi-arid zones at the horizon where ascendant capillary water evaporates and salts held in solution are deposited. 5. A similar deposit, formed by precipitation of salts leached from near-surface material and reprecipitated at shallow depths from downward moving waters^[20]. Synonyms: (French.) *croûte*; (German.) *Kalkkruste*, *Ca-Horizont*; (Greek.) *apóthema oriktón aláton*; (Italian.) *caliche*; (Spanish.) *caliche*; (Turkish.) *kaliçi*. See also *hardpan*; *havara*; *kafkalla*; *kankar*; *kunkar*; *nari*; *calcrete*.

callow. (English.) Top or rubble bed of a quarry.

canal seepage loss. Water lost to the subsurface by seepage through the channel bottom or walls^[16].

canale. (Italian.) Long drowned valley on the Dalmatian coast. Some canali may be drowned poljes^[10].

cáno. (Spanish.) Stream. See also *stream*.

canopy. 1. Overhanging flowstone that projects from a cave wall. It may be a remnant of a once continuous false floor or a mass of flowstone that has built steadily outwards to create its own overhang^[9]. 2. A compound cave formation consisting of flowstone hanging from a sloping wall projection and forming a fringe of shawls or stalactites on the outer edge^[10].

canyon. 1. A steep-walled chasm, gorge, or ravine cut by running water. 2. A chasm that has been formed by a cave stream. 3. A valley formed by collapse of the roof of a long fairly straight cave; a karst valley^[10]. Related to *corridor*. Synonyms: (French.) *canyon, gorge, cañon*; (German.) *Schlucht, Canyon*; (Greek.) *pharangi*; (Italian.) *forra, gola, orrido, canyon*; (Russian.) *kanjon*; (Spanish.) *cañón*;, *garganta*; (Turkish.) *boğaz*; (Yugoslavian.) *klanac, sutjeska, soteska, vintgar*. See also *bogaz*; *chasm*; *gorge*; *ravine*.

canyon passage. 1. A tubular passage (cave) that is formed by underground streams following gently tilted bedding-plane partings or fractures and are eroding channels downward through the rock. Their ceiling heights are greater than their widths. They are similar to surface canyons, but they possess roofs and are generally the same distance apart at the top as they are at the bottom. In Mammoth Cave, most are narrow and winding and may achieve dimensions of 50 feet wide by 100 feet high. If a canyon passage begins forming on an old tube passage, then a keyhole passage may result^[15]. 2. Also known as vadose canyons, these are cave passages, most commonly formed by continued floor entrenchment or incision, by a free-flowing vadose stream. The passage width at any particular level is determined by the flow of the formative stream, the rate of its downcutting, and the effects of any subsequent collapse. Canyon height reflects the stream's downcutting history. It depends upon the vertical distance available for erosional descent to the local base level and the time that erosional downcutting has been active, as well as upon the more obvious but less

important influences of flow rate and erosional capacity. Vadose canyons commonly twist and meander sharply, while maintaining roughly parallel vertical sides. In contrast to some meanders in surface streams, underground meanders must generally be imprinted on a bedding plane before entrenchment of the canyon begins. Narrow canyon passages, commonly less than 1 m wide and more than 20 m high, are a particular feature of deep alpine caves. Perhaps the largest canyon passage in the world is that in Škocjanske Jama, Slovenia, which is over 100 m high and 50 m wide^[9]. See *paragenetic cave*. See also *keyhole passage*; *passage*; *tubular passage*; *vertical shafts*.

capacity. The ability to contain a certain volume or mass^[16].

capacity, carrying. The capacity of a watercourse to transport solids^[16].

capacity curve. A graphic presentation of the rate of discharge in a pipe or conduit or through porous material^[16].

capacity, entrance. The property of a soil to let water infiltrate^[16].

capacity, field; field-carrying; capillary. Soil moisture retained by capillarity and not removable by gravity drainage^[16].
Synonym: *specific retention*.

capacity, ground-water. 1. The ability of soil or rock materials to hold water. The yield of a pump, well, or reservoir.

capacity, hydraulic. The ability of a current of water or wind to transport detritus, as

shown by the amount measured at a point per unit of time.

capacity, infiltration. The maximum rate at which a soil can absorb precipitation for given conditions^[16].

capacity, self-cleaning. The capacity of a river to clean its water from pollutants over a given length of water course^[16].

capacity, specific. The ratio of well discharge to corresponding discharge^[16].

capacity, storage. 1. The ability of an aquifer to store water^[16]. 2. The capacity of rivers to store water in their own channels^[16].

capacity, total. The maximum rate of yield of a well^[16].

capacity, transmission. The property of a porous medium to conduct fluid^[16].

capacity, well. The rate at which a well will yield water^[16].

capillarity. The action by which a fluid, such as water, is drawn up (or depressed) in small interstices or tubes as a result of surface tension.

capillary action. The movement of water in the interstices of a porous medium due to capillary forces^[22]. Synonymous with capillarity, capillary flow, and capillary migration.

capillary attraction. The adhesive force between a liquid and a solid in capillarity.

capillary condensation. The formation of rings of pendular water around point

contacts of grains, when the rings around adjacent contacts become large enough to touch.

capillary conductivity. 1. The property of an unsaturated porous medium to transmit liquid^[22]. 2. Coefficient that expresses the extent to which an unsaturated permeable medium allows flow of water through its interstices, under a unit gradient of capillary potential^[22].

capillary fringe. The lower subdivision of the unsaturated zone immediately above the water table in which the interstices are filled with water under pressure less than that of the atmosphere, being continuous with the water below the water table but held above it by capillary forces^[22].

capillary fringe zone. The zone above the free water elevation in which water is held by capillary action.

capillary head. The potential, expressed in head of water, that causes the water to flow by capillary action^[22].

capillary interstice. An interstice small enough to hold water by surface tension at an appreciable height above a free water surface, yet large enough to prevent molecular attraction from extending across the entire opening.

capillary migration. See *capillary action*.

capillary movement. The rise of water in the subsoil above the water table by capillarity.

capillary percolation. See *imbibition*.

capillary potential. The scalar quantity that represents the work required to move a unit mass of water from the soil to a chosen reference location and energy state^[22].

capillary pressure. The difference in pressure across the interface between two immiscible fluid phases jointly occupying the interstices of a porous medium caused by interfacial tension between the two phases^[22].

capillary rise. The height above a free water surface to which water will rise by capillary action^[22]. Synonymous with height of capillary rise.

capillary stalagmite. Hollow stalagmite formed by saturated karst water pushed up through capillaries and small cracks in a sinter crust covering permeable fluvial deposits on the floor of a cave; first reported from Cuba, where such stalagmites are composed of aragonite^[10].

capillary tension. See *moisture tension*.

capillary water. 1. Water held in the soil above the phreatic surface by capillary forces^[22]. 2. Soil water above hygroscopic moisture and below the field capacity^[22].

carabiner. An oval of steel or aluminum with a movable spring-loaded gate on one side. A locking carabiner is one where the gate is threaded and has a ring that can be threaded over the gate to prevent it from opening^[13].

carbide, calcium carbide. A compound (CaC_2) of grayish color that reacts with water to produce acetylene gas and calcium hydroxide $[\text{Ca}(\text{OH})_2]$ ^[13]. Commonly used by cavers and miners earlier in this century as a means of providing light in caves or

mines. Some cavers still prefer carbide lights over electric lights. See also *carbide lamp*.

carbide lamp. A carbide lamp, also known as a miners' carbide lamp or acetylene lamp was introduced into mine use in about 1897. It consists of two chambers, a water tank above and a removable carbide canister below with a connection valve to permit controlled seepage of water into the calcium carbide. The carbide and water react to generate calcium hydroxide $[\text{Ca}(\text{OH})_2]$ and acetylene gas. The gas is passed through a filter into a tube and through a tiny burner-tip orifice designed for the optimum mixture of air and acetylene. Once ignited, it burns with a brilliant yellow-white flame produced by the incandescence of tiny carbon particles. A reflector concentrates the light in a particular direction^[13].

carbonate. 1. A salt or ester of carbonic acid; a compound containing the radical CO_3^{-2} , such as calcium carbonate, CaCO_3 . 2. A rock consisting mainly of carbonate minerals, such as limestone or dolomite^[10].

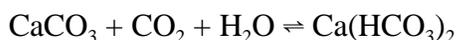
carbonate-fluorapatite. A cave mineral — $\text{Ca}_5(\text{PO}_4, \text{CO}_3)_3\text{F}$ ^[11].

carbonate hardness. Hardness of water due to presence of dissolved bicarbonates of calcium and magnesium that can be removed by boiling, hence the term "temporary hardness." Synonyms: (French.) *dureté temporaire*; (German.) *temporäre Härte, Carbonathärte*; (Greek.) *parothiki sklipotis anthrakiki sklirotis*; (Italian.) *durezza temporanea*; (Russian.) *karbonatnaja zestkostj*; (Spanish.) *dureza temporal*; (Turkish.) *karbonat sertliđi*; (Yugoslavian.) *turdoóa, trdota*.

carbonate-hydroxylapatite. A cave mineral — $\text{Ca}_5(\text{PO}_4, \text{CO}_3)_3(\text{OH})$ ^[11].

carbonate rock. A rock that consists of one or more carbonate minerals. Carbonate rock successions (or sequences) are those in which carbonate rock is dominant, but which also contain rocks of other lithology^[9].

carbonic acid dissolution. Dissolution of calcium carbonate by carbon dioxide in aqueous solution, loosely termed carbonic acid, is the dominant reaction in karst processes, including speleogenesis. The reaction can be considered in several ways but it is most simply represented as:



cascading water. In reference to wells, ground water that trickles or pours down the casing or uncased borehole above the water level in the well through cracks or perforations^[22].

casing. Permanent liner of a well^[16].

casing joint. Welded or threaded connection for tubular casing^[16].

casing, surface. That part of a well casing that extends above land surface^[16].

catch basin. 1. A reservoir or basin into which surface water may drain. 2. A basin to collect and retain material from a street gutter that would not readily pass through a sewer system.

catchment. (Great Britain.) 1. An area into which surface water may drain. 2. A

depression that collects rainwater (e.g., reservoir).

cation. An ion having a positive charge and, in electrolytes, characteristically moving towards a negative electrode^[6].

cation exchange. Ion exchange process in which cations in solution are exchanged for other cations from an ion exchanger^[6].

cation exchange capacity. The sum total of exchangeable cations that a porous medium can absorb. Expressed in moles of ion charge per kilogram of soil (or of other exchanges such as clay)^[22].

cause. (French.) A limestone plateau in the southeastern part of the central massif of France characterized by closed depressions, caves, and avens (jamas); a number of such plateaus in and around the basin of the river Tarn constitute Les Grandes Causses. This region was considered by Cvijić to exemplify karst development intermediate - between holokarst and merokarst^[10]. Synonym: (French.) *cause*; (German.) *Kalkstein Plateau, Causse*; (Greek.) *karstikón oropédion*; (Italian.) *altopiano carsico*; (Russian.) *izvestnjakovoje karstovoje plato*; (Spanish.) *altiplano carstico*; (Turkish.) *kireçtaşı düzlüğü*; (Yugoslavian.) *krški plato, kraški plato*.

cave. 1. “A natural hole in the ground, large enough for human entry” is probably the most useful definition. This covers the enormous variety of caves that do occur but eliminates the many artificial tunnels and galleries incorrectly named caves. The size criterion is arbitrary and subjective, but practical, as it eliminates narrow openings irrelevant to explorers but very significant

hydrologically, that may be better referred to as *proto-caves*, *sub-conduits*, or *fissures*. A cave may be a single, short length of accessible passage, or an extensive and complex network of tunnels as long as the hundreds of kilometers in the Flint Mammoth Cave System. Most caves are formed by dissolution in limestone, but *sandstone caves*, *lava caves*, *glacier caves* and *tectonic caves* also occur. Marginal candidates for use of the name “cave” include riverbank undercuts and rock shelters of various origins. In some countries a cave is regarded as being a horizontal opening, as opposed to a pothole, which is a vertical opening. This usage is common in England but is not ubiquitous^[9]. 2. A natural opening formed in the rocks below the surface of the ground large enough for a human to enter. It may consist of a single connected opening or a series of small or large chambers connected by galleries^[20]. 3. A similar artificial opening^[10]. Related to *cavern*. Synonyms: (French.) *grotte*, *caverne*; (German.) *Höhle*, *Grotte*; (Greek.) *speleon*; (Italian.) *caverna*, *grotta*; (Russian.) *pescera*; (Spanish.) *cueva*; (Turkish.) *mağara*; (Yugoslavian.) *pečina*, *peč*, *peštera*, *spilja*, *zijjalka*, *jama*. See also *active cave*; *bedding cave*; *cave system*; *grotto*; *sea cave*.

cave balloon. See *cave blister*.

cave blister. 1. A small pimplelike cave formation, roughly oval in shape, generally loose, and having a core of mud^[10]. 2. A partly or completely hollow hemispherical to nearly spherical speleothem, usually of gypsum or hydromagnesite, attached to a cave wall. Synonym: *cave balloon*.

cave breakdown. 1. Enlargement of parts of a cave system by fall of rock masses from walls and ceiling. 2. Heaps of rock that have collapsed from the walls and ceiling of a cave, generally called *cave breccia*^[10]. 3. Synonym for the collapse of caves, or, in American usage, for the debris produced by collapse^[18].

cave breathing. A resonance phenomenon in which air currents throb back and forth through constricted passages in a cave with periodicity of a few seconds to a few minutes. Synonyms: (French.) *passage respirant*; (German.) *Grotte mit Resonanz*; (Greek.) *anapneousa ope*; (Italian.) *grotta a soffio alterno*; (Spanish.) *gruta resonante*; (Turkish.) *mağara esintisi*. See also *blowing cave*.

cave breccia. Angular fragments of rock forming a fill in a cave, either cemented together by dripstone or in a matrix of cave earth^[10]. See also *solution breccia*.

cave bubble. A nonattached hollow sphere, usually of calcite, that has formed around a gas bubble on the surface of a cave pool.

cave coral. A rough, knobby growth of calcite resembling coral in shape, generally small; found on the floor, walls, or ceiling of a cave^[10]. Synonym: *botryoid*; *coral formation*; *cave popcorn*. See also *knobstone*.

cave cotton. Thin flexible filaments of gypsum or epsomite projecting from a cave wall. Synonym: *gypsum cotton*. See also *gypsum flower*.

cave development. The inception of cave development in carbonate rocks begins if water can move through the bedrock and

commence dissolution. The earliest water movement may be due to mechanisms (including ground-water pumping and ionic diffusion effects) unrelated to those dominating later development. Similarly, inception may include physical and chemical dissolution (involving removal of carbonates and mineral impurities by water and by strong acids), as well as by the carbonic acid dissolution that dominates later cave growth. Initial water movement can be along primary pores in the rock (in coarse raffle limestones, oolites, or chalk), along relatively thin noncarbonate beds within the succession, or along incipient or open fissures (joints, faults, and bedding planes). These potential water routes are initially very narrow and water movement is severely restricted and laminar, allowing only very slow dissolutional growth (see *gestation*), until enlargement beyond the turbulent threshold (breakthrough) permits faster flow and accelerated cave growth. After establishment of turbulent flow conditions, the effects of dissolution are augmented by mechanical abrasion and collapse, which expose new rock. During the early development stages a network of narrow openings is formed. Subsequently, geological factors guide the preferential expansion of favorable routes, which capture more of the local flow and enlarge, at the expense of less favorable openings, to form caves. The less favorable fissures are relegated to a subordinate role in transmitting percolation water or, more rarely, in carrying elements of overflow water during floods. Also during the early stages, all voids are water filled, but as permeability increases and true hydraulic flow conditions are established, the upper voids drain freely, forming a water table. Almost all caves therefore originate under

phreatic conditions, but the overall passage morphology is modified during later growth into vadose or phreatic caves, enlarged from the original phreatic imprint, above or below the water table. Ultimately, cave development evolves toward efficient drainage close to the water table. Passage enlargement then becomes regressive as collapse increases. The stage of a cavernous karst collapsing extensively is relatively rare, being overtaken at high latitudes and high altitudes by surface lowering, but such collapse can contribute to the chaotic landforms of tropical karst^[9].

cave earth, cave fill. Insoluble deposits of clay, silt, sand, or gravel flooring or filling a cave passage. In a more restricted sense, cave earth includes only the finer fractions: clay, silt, and fine sand deposits^[10]. Synonym: *cave soil*.

cave flower. An elongate curved deposit of gypsum or epsomite on a cave wall in which growth occurs at the attached end^[10]. Synonyms: *gypsum flower*; *oulopholite*. See also *anthodite*; *cave cotton*.

cave formations. 1. Secondary mineral deposits formed by the accumulation, dripping, or flowing of water in a cave^[10]. 2. Unsatisfactory term used to include all varieties of calcite, gypsum and other, rarer, mineral cave deposits; therefore a synonym for the equally unwieldy “speleothem” or the colloquial term “stall”^[9]. See also *sinter*; *speleothem*.

cave group. A number of caves or cave systems, not interconnected but geographically associated in some relief feature or particular geological outcrop^[10]. See also *cave series*.

cave guano. Accumulations of dung in caves, generally from bats; in some places partially mineralized^[10].

cave ice. Ice formed in a cave by natural freezing of water. Loosely but incorrectly applied to calcium carbonate dripstone and flowstone^[10].

cave-in. 1. The collapse of the ceiling or side walls of a cave or of the land surface into a subterranean passage as a result of undermining or of pressure from above^[10]. 2. The partial or complete collapse of earth material into a large underground opening, such as an excavation or a mine. 3. The sudden slumping of wall material into a pit. 4. A place where material has collapsed or fallen in or down.

cave-in lake. A shallow body of water whose basin is produced by collapse of the ground following thawing of ground ice in regions underlain by permafrost. Synonym: *thermokarst lake*.

cave lake. Any underground lake. The water can be in a partially drained phreatic cave, and may then be the entrance to a sump, or it can be open over its entire surface. In vadose caves lakes are most commonly formed by ponding behind banks of sediment or, in rarer cases, behind very large gour barriers^[9].

cave marble. Banded deposit of calcite or aragonite capable of taking a high polish^[10]. See also *flowstone*; *onyx marble*.

cave of debouchure. Outflow cave.

cave onyx. See *onyx marble*.

cave pearl. 1. Carbonate concretion, usually of calcite, that is spherical or irregular in shape, with an internal structure of concentric banding round a central grain. Pearls form in pools of saturated water disturbed by dripping water, so that they are commonly found beneath high avens. Individual pearls may be 1 mm or many centimeters in diameter. Movement of the larger ones may become impossible and they can then become cemented to the pool floor. Some caves contain spectacular displays of cave pearls; in Jackson's Bay Cave, Jamaica, they cover large areas of passage floor behind low gour barriers^[9]. 2. Small concretion of calcite or aragonite formed by concentric precipitation around a nucleus^[10]. Synonyms: *pisolite*; *pisolith*; (French.) *perle des cavernes*; (German.) *Höhlenperlen*; (Greek.) *speleomargarites*; (Italian.) *perle di grotta*; (Russian.) *pescernij zemcug*; (Spanish.) *perla de caverna*; (Turkish.) *mağara incisi*; (Yugoslavian.) *pećinski biseri*, *jamski biseri*.

cave pisolite. See *cave pearl*.

cave popcorn. See *cave coral*.

caver. (American.) 1. A slang term for one who engages in the hobby of cave exploration, or caving^[9, 21]. 2. A person who explores caves in a safe manner while showing respect for the cave (all aspects of the cave), other cavers, and the land above the cave^[13]. Synonym: *spelunker*; (British.) *potholer*. See also *speleologist*.

cave raft. A thin mineral film, usually of calcite, floating on a cave pool.

Cave Research Foundation (CRF.) An organization of cavers united primarily for scientific exploration and study of caves^[13].

cavern. 1. Underground opening in soluble rock similar to a cave. When used as a noun, it refers to large openings, but when used as an adjective it tends to refer to rock texture and so to small openings. However, in some countries (e.g., Russia) “cavern” refers to small openings in a rock^[20]. 2. A synonym of “cave” with the implication of large size. 3. A system or series of caves or cave chambers. 4. A cave, often used poetically or to connote larger-than-average size^[10]. Synonyms: (French.) *caverne*; (German.) *Höhle, Kaverne*; (Greek.) *speleon*; (Italian.) *caverna, grotta*; (Russian.) *kaverna*; (Spanish.) *caverna, cueva*; (Turkish.) *kovuk*; (Yugoslavian.) *kaverna*. See also *cave*.

cavern breakdown. The process of cave enlargement, which depends upon the mechanical failure and eventual collapse of sections of the cavern walls and ceiling^[22].

cavern flow. Movement, often turbulent, of ground-water flow through caves, coarse sorted gravel, or large open conduits, either by gravity or under pressure.

cavernous. Adjective used to describe a rock texture in which the rock contains openings generally of a small size^[20]. Synonyms: (French.) *caverneux*; (German.) *kavernös*; (Greek.) *speleother*; (Italian.) *con grotte*; (Russian.) *kavernoznij*; (Spanish.) *cavernoso*; (Turkish.) *kovuklu*; (Yugoslavian.) *kavernozan*. See also *cavern*.

cavernous karren. Pitted, rubbly limestone most commonly found in relatively recent and Tertiary limestones of the humid tropics^[3]. See also *covered karren*; *karren*.

cavernous permeability. See *conduit permeability*.

cavernous rock. Any rock that has many cavities, cells, or large interstices (e.g., a cliff face pitted with shallow holes resulting from cavernous weathering).

cavernous weathering. Chemical and mechanical weathering on a cliff face, in which grains and flakes of rock are loosened so as to enlarge hollows and recesses.

cavern porosity. A pore system having large, cavernous openings. The lower size limit, for field analysis, is practically set at approximately the smallest opening that an adult person may enter.

cavern system. See *cave system*.

cave series. A group of caves of similar morphology in a particular district^[10]. See also *cave group*.

cave shield. A semicircular plate of reprecipitated calcite located beneath joints in a cavern ceiling and believed to be formed by the seepage of hydrostatic water along the joint. Two shields form beneath one joint, descending from each side of the opening^[22].

cave soil. See *cave earth*.

cave spring. See *spring, cave*.

cave system. 1. An underground network of passages, chambers, or other cavities. 2. The caves in a given area related to each other hydrologically, whether continuous or discontinuous from a single opening^[10]. Synonyms: (French.) *réseau souterrain*; (German.) *Höhlensystem*; (Greek.) *speleothés systema, thiction*; (Italian.) *sistema carsico sotterraneo*; (Russian.) *sistema podzemnih pescer*; (Spanish.) *sistema de cavidades*; (Turkish.) *mağara sistemi, serisi*; (Yugoslavian.) *pećinski (spiljski) sistem, amski sistem*. See also *cave*; *cave group*; *cave series*; *cavern*.

caving. The sport of exploring caves. Synonyms: (British.) *potholing*; *spelunking*. 2. A method of mining in which the ore is allowed to cave or fall^[10].

cavings. Rock fragments that fall from the walls of a borehole and contaminate the well cuttings or block the hole. These fragments must be removed by drilling or circulation of drilling fluids before the borehole can be deepened.

cavitation. 1. The collapse of bubbles in a fluid, caused by static pressure being less than the fluid vapor pressure. 2. A phenomena of cavity formation, or formation and collapse, especially in regard to pumps, when the absolute pressure within the water reaches vapor pressure causing the formation of vapor pockets^[6].

cavity. A solutional hollow in a limestone cave.

cavity dweller. A coelobitic organism.

ceiling block. Roughly cubical joint-bounded large block, which has fallen from the

ceiling of a cave^[10]. See also *cave breakdown*; *ceiling slab*.

ceiling cavity. Solutional concavity in the ceiling of a cave. The orientation is determined by joints or a bedding plane^[10].

ceiling channel. Sinuous channel developed in the ceiling of a cave, presumably during the phreatic phase of cave development^[10].

ceiling meander. A winding upside-down channel in a cave ceiling^[10].

ceiling pocket. See *pocket*.

ceiling slab, roof slab. A thin but extensive piece of rock that has fallen from the ceiling of a cave in roughly horizontal limestone^[10]. See also *cave breakdown*; *ceiling block*.

ceiling tube. A half tube remaining in the ceiling of a cave^[10].

celestite. A cave mineral — SrSO_4 ^[11].

cement. A microscopic textured nonskeletal void-filling material precipitated on an intragranular or intrasedimentary free surface that holds the material together^[20]. Synonyms: (French.) *ciment*; (German.) *Zement*; (Greek.) *tsiménto*; (Italian.) *cemento*; (Spanish.) *cemento*; (Turkish.) *çimento*; (Yugoslavian.) *vezivo cement*.

cementation. The process of binding granular material together by deposition of cementing material at contact points of grains^[16].

cement grout. Cement slurry of pumpable consistency^[16].

cement slurry. Liquid cement suspension^[16].

cementing. See *grouting*.

cenote. (Spanish, after Mayan *tzonet* or *dzonot*.) 1. Steep-walled natural well that extends below the water table; generally caused by collapse of a cave roof. Term used only for features in Yucatán^[10]. 2. Steep or vertical-sided collapse doline floored by a lake whose surface is at the regional water table. The term originates from the many cenotes in the low karst plateau of Mexico's Yucatan, but has been applied to flooded dolines in Florida and elsewhere. Probably the most famous cenote is the sacred well of Chichen Itza, Yucatan; it has vertical sides and is 60 m in diameter, 30 m deep, and half full of water^[9]. Synonyms: (French.) *cenote*; (German.) *cenote*; (Greek.) *voulismeno speleven*. See also *jama*; *natural well*.

centrifuge moisture equivalent. See *moisture equivalent*.

cerussite. A cave mineral — PbCO_3 ^[11].

chain gage. Water level measuring device^[16].

chalk. 1. Used as a proper noun, “chalk” describes a rock unit of Cretaceous age that consists predominately of relatively soft, white, porous limestone with beds of marl and bands or nodules of flint. The term is used without its initial capital to describe any rock with similar appearance and properties. Generally chalk has a relatively high primary permeability and so rarely develops caves of explorable size, though conduit-water flow does occur. Some harder chinks in northern France and southeastern England hold explorable active

and relict caves, which extend for many hundreds of meters^[9]. 2. Soft poorly indurated limestone, generally light in color; commonly composed of the tests of floating microorganisms in a matrix of very finely crystalline calcite^[10].

chalcantite. A cave mineral — $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ^[11].

chamber. (American.) 1. An enlargement in a cave passage or system, commonly formed at a junction of passages, or locally in a single passage, where erosion has been enhanced by collapse exposing more rock to dissolution. Maximum chamber size is controlled by the strength and shape of the limestone ceiling. The largest chamber currently known, Sarawak Chamber in Lubang Nasib Bagus, at Mulu, Sarawak, is over 700 m long, up to 400 m wide, and nowhere less than 70 m high. It has formed where a large stream eroded sideways as it cut obliquely across the included bedding in unusually massive limestone. It is doubtful whether a much larger chamber could exist without collapse of its roof^[9]. 2. The largest order of cavity in a cave or cave system; it has considerable length and breadth but not necessarily great height. 3. (British.) A room in a cave^[10]. Synonyms: (French.) *salle*; (German.) *Halle*, *Kammer*, *Dom*; (Greek.) *ypoyios aethousa*; (Italian.) *sala*; (Russian.) *zal*; (Spanish.) *sala*, *salón*; (Turkish.) *oda*; (Yugoslavian.) *dvorana*. See also *room*; *passage*.

chandelier. Large variety of gypsum flower, with branching crystal structure that may hang many meters from a cave ceiling. Very rare, except in Lechuguilla Cave of New Mexico^[9].

channel. Natural or artificial watercourse bounded by banks^[16].

channel characteristics. Hydraulic properties of stream channel^[16].

chasm. 1. A deep, fairly narrow breach in the earth's surface; an abyss; a gorge; a deep canyon. 2. A deep, wide, elongated gap in the floor of a cave^[10]. Related to *canyon*, *corridor*. Synonyms: (French.) *gouffre*, *fracture ouverte*; (German.) *Kluft*; (Greek.) *chasma*; (Italian.) *fattura beante*, *canyon*; (Spanish.) *cañon*, *taso*; (Turkish.) *derin yarntı*; (Yugoslavian.) *provalija*. See also *ravine*.

chemical carbonate rock. Carbonate rock formed by the precipitation of mineral matter in situ by chemical or biological processes.

chemical deposit. A sediment precipitated out of solution by chemical action^[16].

chemical erosion. Processes partially synonymous with chemical dissolution, but including any other form of rock breakdown accelerated by chemical changes of the constituent minerals^[9].

chemical equivalent. The expression of water characteristics such as hardness or alkalinity resulting from several ions in solution in terms of only one equivalent concentration^[16].

chemical mobility. The tendency of an element to move in a given hydrogeochemical environment^[16].

chemical oxygen demand (COD). The measure of readily available oxidizable material contained in a water sample^[16].

chert, chert nodule. 1. Black, brown, or gray rock, consisting of very fine-grained silica, that occurs as horizons of nodules and discontinuous bands, generally less than 200 mm thick, within many limestones. It is very hard and almost insoluble in water, so it commonly projects from cave walls where it forms passage or shaft ledges and waterfall lips^[9]. 2. Light-cream or gray to black rock composed of silica, found as nodules or layers in limestone, or as a replacement of limestone^[10].

Chézy equation. An equation used to compute the velocity of uniform flow in an open channel: mean velocity of flow (V) equals the Chézy coefficient © times the square root of the product of hydraulic radius in feet (R) times the slope of the channel^[1]. See also *Froude number*; *Manning equation*; *Reynolds number*.

chimney. 1. Nearly circular shaft rising upwards from the ceiling of a cave towards the surface of the ground; if it does not reach the surface it is termed a blind chimney. If the chimney is formed mainly by solution, it is related to a dome-pit; if formed mainly by collapse of the roof along bedding planes, it is related to a cenote^[20]. 2. A narrow vertical shaft in the roof of a cave, generally smaller than an aven; a dome pit^[10]. Synonyms: (French.) *cheminée* (aven); (German.) *Schlot*, *Kamin*; (Greek.) *kapnothochos*; (Italian.) *camino*; (Russian.) *truba*; (Spanish.) *chimenea*; (Turkish.) *baça*; (Yugoslavian.) *dimnjak*.

chockstone. A rock wedged between the walls of a cave passage^[10].

choke. 1. A blockage of inwashed mud, sand, or boulders in a cave passage. Most boulder chokes are formed by collapse of a passage roof and may have an open chamber or shaft above them; others are formed by collapse and inwashed debris where a large old passage is cut by a hillside. A passable route through a choke may be opened by excavation, and thereby lead to discovery of new passage, as was done so successfully in Ogof Agen Allwedd^[9]. 2. Rock debris or cave fill completely blocking a passage^[10].

C-horizon. Zone of weathered parent material in a soil profile^[16].

chute. An inclined channel or trough in a cave^[10].

ciénaga. (Spanish.) Wetland. See also *wetland*.

cimolite. A cave mineral — $\text{Al}_4(\text{SiO}_2)_9(\text{OH})_{12}$ ^[11].

cistern. A small water reservoir used to collect surface and rain water^[16].

classical karst. Originally the region called Kras in Slovenia, which gave its name to the karst landscape. Used in this sense, about 95% of classical karst lies in Slovenia, with the remaining 5% extending to Italy. A slightly different area was covered by descriptions of early investigations of karst phenomena, when the name classical karst was applied to a region between Ljubljana, Gorizia, and

Rijeka, mainly in Slovenia with some parts in Italy and Croatia^[9].

clastic. Pertaining to a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and that have been transported some distance from their places of origin^[6].

clastic carbonate rock. Carbonate rock that is made up of carbonate grains (e.g., shells, shell fragments, oolites).

clastic rock; detrital rock. A sedimentary rock derived from fragmented other preexisting rock or organic structures^[16].

clastokarst. Karst phenomena in clastic rocks composed of detrital carbonate material^[20]. Synonyms: (French.) *clastokarst*; (German.) *Klastokarst*; (Greek.) *clastokarst*; (Italian.) *carsismo clastico*; (Russian.) *klastokarst*; (Spanish.) *clastokarst*; (Turkish.) *klastik karst*; (Yugoslavian.) *klastokr̃s klastokras, klastokarst*.

clay. 1. A rock or mineral fragment or a detrital particle of any composition smaller than a very fine silt grain, having a diameter less than 1/256 mm (4 microns, or 0.00016 in., or 8 phi units.) This size is approximately the upper limit of particles that can show colloidal properties. 2. A loose, earthy, extremely fine-grained natural sediment or soft rock composed primarily of clay-size or colloidal particles and characterized by a considerable content of clay minerals and subordinate amounts of finely divided quartz, decomposed feldspar, carbonates, ferruginous matter, and other impurities. It forms a plastic, moldable mass when finely ground and mixed with water, but retains its shape on drying, and

becomes firm, rocklike, and permanently hard on heating or firing. 3. A term that is commonly applied to any soft, adhesive, fine-grained deposit (such as loam or siliceous silt) and to earthy material, particularly when wet (such as mud). 4. A term used by the International Society of Soil Science for a rock or mineral particle in the soil, having a diameter less than 0.002 mm (2 microns).

clay ball, clayball. A chunk of clay released by erosion of a clayey bank and rounded by wave action.

clay boil. A mud circle that suggests a welling-up or heaving of the central core.

clay colloid. 1. A clay particle having a diameter less than 1 micron (0.001 mm). 2. A colloidal substance consisting of clay-size particles.

clay fill. Dry or wet clay that fills a cave passage^[10].

clay filling. Time interval between end of phreatic solution of a cave and beginning of deposition of flowstone^[10].

clayey sand. 1. An unconsolidated sediment containing 50%-90% sand and having a ratio of silt or clay less than 1:2. 2. An unconsolidated sand containing 40%-75% sand, 12.5%-50% clay, and 0%-20% silt.

clayey silt. 1. An unconsolidated sediment containing 40%-75% silt, 12.5%-50% clay, and 0%-20% sand. 2. An unconsolidated sediment containing more particles of silt size than of clay size, more than 10% clay, and less than 10% of all other coarser sizes.

clay loam. A soil containing 27%-40% clay, 20%-45% sand, and the remainder silt.

clay marl. 1. A whitish, smooth, chalky clay. 2. A marl in which clay predominates.

clay mineral. One of a complex and loosely defined group of finely crystalline, metacolloidal, or amorphous hydrous silicates, essentially of aluminum.

clupein. A dense, heavy, relatively impervious subsurface soil layer that owes its hardness to a relatively higher clay content than that of the overlying material from which it is separated by a sharply defined boundary.

clay parting. 1. Clayey material between a vein and its wall. 2. A seam of hardened carbonaceous clay between or in beds of coal, or a thin layer of clay between relatively thick beds of some other rock (e.g., sandstone).

clay plug. Fine flood deposits in a cut-off river meander^[16].

clean sand. Sand with little or no clay content^[16].

cleavage. The tendency to cleave or split along definite parallel planes, which may be highly inclined to the bedding. It is a secondary structure and is ordinarily accompanied by at least some recrystallization of the rock.

climatic factor. A factor influencing hydrologic parameters due to the local climate^[16].

clint. (British.) 1. Flat or sloping bare limestone outcrops (limestone pavements) weathered into straight-sided or furrowed blocks and ridges of limestone which are separated by deep clefts or solutionally widened joints (grikes) that often crisscross^[20]. 2. Slabs of limestone, parallel to the bedding, forming a pavement. Widened joints, or grikes, isolate individual clints^[10]. Synonym: (French.) *lapiaz*; (German.) *Flachkarren, Karrenfeld*; (Greek.) *pethion amaxotrochion thactyloglyphon*; (Italian.) *campo carreggiato*; (Russian.) *karrovoe pole*; (Spanish.) *campo de lapiaz, lenar*; (Turkish.) *pürtüklü, oluklu*; (Yugoslavian.) *škrapari, škraplje*. See also *grikes*; *karrenfeld*; *lapias*; *limestone pavement*.

clog, to. The action of blocking fluid flow paths, especially around a well bore^[16].

closed depression, closed basin. 1. Any karst hollow with internal drainage, including dolines, uvalas, poljes, cockpits, and all varieties of blind karst valleys of both small and large scales^[9]. 2. A general term for any enclosed topographic basin having no external drainage, regardless of origin or size^[10].

closed karst. A karst terrane that is covered by sediments. Synonyms: (Russian.) *skrytyĭ karst* or *zakrytyĭ karst*. See also *buried karst*; *interstratal karst*; *mantled karst*.

cloud. Large masses of coralloid or botryoidal calcite, deposited under water, with each mass reaching 200-800 mm in diameter. Famous examples hang above the Lake of the Clouds in Carlsbad Caverns, New Mexico^[9].

clusterite. See *botryoid*.

coarse. Composed of or constituting relatively large particles.

coarse sand. 1. A geologic term for a sand particle having a diameter in the range of 0.5-1 mm (500-1000 microns, or 1 to zero phi units.) 2. An engineering term for a sand particle having a diameter in the range of 2 mm. 3. A soil term used in the U.S. for a sand particle having a diameter in the range of 0.5-1 mm (the diameter range recognized by the International Society of Soil Science is 0.2-2 mm).

coarse silt. A geologic term for a silt particle having a diameter in the range of 1/32 to 1/16 mm (31-62 microns, or 5 to 4 phi units).

cockpit. (Jamaican.) 1. Any closed depression having steep sides. 2. A star-shaped depression having a conical or a lightly concave floor. The surrounding hill slopes are steep and convex. Cockpits are the common type of closed depressions in a *kegelkarst*^[10].

cockpit karst. (Jamaican.) 1. Term describing an area containing numerous scattered, yet closely spaced dolines; generally a tropical karst land form. The corresponding Yugoslav term may more accurately be translated as "pock-marked" karst. 2. Tropical karst topography containing many closed depressions surrounded by steep-sided conical hills. Divided by French and German geographers into several types depending on shape of hills^[10]. Synonyms: (French.) *karst cockpit*; (German.) *Turmkarst, Kegelkarst*; (Greek.) *dolinvrithes karst*; (Italian.) *campo carsico*

a doline; (Spanish.) *karst esponja*; (Turkish.) *düdenli karst*; (Yugoslavian) *boginjavi krš*, *kozavi kras*. See also *cone karst*; *Halbkugelkarst*; *Kegelkarst*; *Spitzkegelkarst*; *tower karst*.

coefficient of compressibility.

Compressibility is the aptitude of the soil to be deformed. It is expressed by means of a coefficient, which is the ratio between a void ratio decrease from e_0 to e and an increase in effective stress. The value $a_v = e_0 - e / \Delta p$ represents the coefficient of compressibility for the range p_0 to $p_0 + p$. Units are usually $\text{cm}^2/\text{kg}^{[21]}$. See also *coefficient of volume compressibility*.

coefficient of permeability. An obsolete term that has been replaced by the term *hydraulic conductivity*^[6].

coefficient of storage. See *storage coefficient*.

coefficient of transmissivity; coefficient of transmissibility. An obsolete term replaced by the term *transmissivity*.

coefficient of volume compressibility. The compression of a clay (aquitar) per unit thickness, due to a unit increase of effective stress, in the load range exceeding preconsolidation stress. It is expressed by the equation

$$m_v = \frac{a_v}{1 + e_0}$$

in which e_0 is the initial void ratio. Units are usually $\text{cm}^2/\text{kg}^{[21]}$. See also *coefficient of compressibility*.

cohesion. Shear resistance at zero normal stress. An equivalent term in rock mechanics is intrinsic shear strength.

coliform organism. A microorganism, the concentration of which is used as an indication of the degree of biological pollution of water^[16].

collapse breccia. A mass of rock composed of angular to rounded fragments of limestone or dolomite that has formed as the result of the collapse of the roof of a cave, of an underlying cave, or of an overhanging ledge^[10]. See also *solution breccia*.

collapse chamber. An underground chamber containing notable quantities of collapsed material. The term is commonly abused in describing the origin of cave chambers floored by collapse debris. Though wall and roof collapse are common modifying processes in larger chambers, it is important to remember that such collapse cannot form a chamber, as it can only take place into a pre-existing cavity^[9].

collapse sink; collapse sinkhole. 1. A variety of closed depression that forms by collapse of the rock above an existing cave passage or chamber^[9]. 2. A closed depression formed by the collapse of the roof of a cave^[10]. See also *doline*.

collapse of caves. Collapse and breakdown of cave walls and ceilings are continuing aspects of cave development and modification. Massive unfractured limestone can easily span a void of over 100 m, but thinly bedded, closely jointed, faulted, or poorly lithified limestone may collapse into very small passages. Collapse

is a significant component of cave erosion. As well as simple falls of unsupported rock forming connections between passages, the collapse process exposes more rock surface area for potential dissolution. As rates of collapse are measured on a geological time scale, collapse in natural caves offers a negligible threat to explorers, in comparison to the dangers of roof collapse in mines^[9].

collector well. A central well with horizontal sections of screened collector pipe arranged radially to increase yield^[16].

colloid. Extremely small solid particles, 0.0001 to 1 micron in size, that will not settle out of solution. It is intermediate between a true dissolved particle and a suspended solid, which will settle out of solution^[6].

column. 1. A subsurface dripstone formation produced by the union of a stalactite and a stalagmite in a cave^[20]. 2. A flowstone formation, generally cylindrical, formed by the union of a stalactite and stalagmite^[10]. Not to be confused with “pillar.” Synonyms: (French.) *colonne, pillier stalamitique*; (German.) *Tropfstein-Säule*; (Greek.) *stalaktitike stele*; (Italian.) *colonna (stalagmitica o stalattitica)* (Russian.) *kolonna*; (Spanish.) *columna*; (Turkish.) *sütun*; (Yugoslavian.) *stup, steber, stolpīc*. See also *pillar*.

comminution. The reduction of a substance to a fine powder; pulverization; trituration.

compaction. A decrease in the volume of a mass of sediments from any cause. In general, compaction may be regarded as the decrease in the thickness of sediments, as a result of an increase in vertical compressive

stress, and is synonymous with “one-dimensional consolidation,” as used by engineers. The term “compaction” is applied both to the process and to the measured change in thickness. In thick fine-grained beds, compaction is a delayed process involving the slow escape of pore water and the gradual transfer of stress from neutral to effective. Until sufficient time has passed for excess pore pressure to decrease to zero, measured values of compaction are transient^[21]. See also *compaction, residual; compaction, specific*.

compaction, residual. Compaction that would occur ultimately if a given increase in applied stress were maintained until steady-state pore pressures were achieved, but had not occurred as of a specified time because excess pore pressures still existed in beds of low diffusivity in the compacting system. It can also be regarded as the difference between (1) the amount of compaction that will occur ultimately for a given increase in applied stress, and (2) that which has occurred at a specified time^[21]. See also *compaction; compaction, specific*.

compaction, specific. The decrease in thickness of deposits, per unit of increase in applied stress, during a specific period of time^[21]. See also *compaction; compaction, residual*.

complete well penetration, fully penetrating. 1. The property of a well that penetrates an aquifer completely from the upper confining bed or water table to the lower confining bed^[16]. 2. A well that is completed over the whole thickness of the aquifer to allow radial production over its entire completed length^[16].

compressibility. The relative change in volume with pressure of water or aquifer matrix^[16].

compressive stress. Normal stress tending to shorten the body in the direction in which it acts.

compromise boundary. 1. A plane interface between two crystals that evolved by mutual interference of their respective growing faces. This interface is a face of neither crystal. 2. A microscopic texture^[20].

concentration gradient. The change in solute concentration per unit distance in solute. Concentration gradients cause *Fickian diffusion* (spreading) of solutes from regions of highest to regions of lowest concentrations. In slowing moving ground water, this is the dominant mixing process^[22].

concretion. The localized deposition of mineral matter going out of solution in sediments or tuffs, usually nodular or irregular in shape^[16].

condensation. The transition from vapor to liquid state^[16].

condensation nucleus. A small solid particle around which condensation occurs^[16].

condensation water. Atmospheric moisture deposited inside caves when the surface temperature of the exposed rock falls below the dew point of circulating air^[19].

conduit; karst conduit. Relatively large dissolutional voids, including enlarged fissures and tubular tunnels; in some usage the term is restricted to voids that are

water-filled. Conduits may include all voids greater than 10 mm in diameter, but another classification scheme places them between arbitrary limits of 100 mm to 10 m. Whichever value is accepted in a particular context, smaller voids are commonly termed subconduits^[9]. Synonyms: (French.) *conduite forcée*; (German.) *Druckleitung (Leitung)*; (Greek.) *siphon*; (Italian.) *condotta forzata*; (Spanish.) *conducto saturado*; (Turkish.) *yeraltsu yolu, mecra*. See also *pressure flow tube*; *stream tube*; *siphon*.

conduit flow; karst conduit flow. Underground water flow within conduits. Conduit flow is generally turbulent, but can also be laminar^[9].

conduit permeability. Sometimes referred to as cavernous permeability, this is a measure of the efficiency with which a particular aquifer transmits water through conduits (see permeability)^[9].

conduit porosity. That part of the porosity within an aquifer (usually a karst aquifer) that is a function of the presence of conduits^[9].

cone of depression. A depression of the potentiometric surface in the shape of an inverted cone that develops around a well that is being pumped. It defines the area of influence^[6]. Synonym: *cone of pressure relief* (applied to artesian aquifers only).

cone of impression. A rise of the potentiometric surface in the shape of a cone that develops around an injection well^[22].

cone karst. 1. A karst landscape dominated by low conical (or hemispherical) hills that forms only in wet tropical climates. The type example is Gunung Sewu in Java. Individual hills are remarkably uniform, each some few hundred meters in diameter and around 50 m high. Between them lie broken valleys, dolines, or cockpits, draining into sinkholes. Erosion that seems to be initiated in valley systems develops in such a way that the valleys break up into dolines, but the mechanisms leading to uniform shaping of the hills are not fully understood. The widespread cone karst in China is mostly known as fengcong, and its hills are generally more conical than hemispherical in profile^[9]. 2. A type of karst topography, common in the tropics, characterized by star-shaped depressions or dolines at the feet of many steep-sided cone-shaped hills; narrow steeply-walled valleys may be present^[10, 20]. A variety of *Kegelkarst*. Synonyms: (French.) *karst à pitons*; (German.) *Kegelkarst, Turmkarst*; (Greek.) *konoethes karst*; (Italian.) *carso di torri, carsismo con forme residuali coniche*; (Russian.) *karst s koniceskimi ostancami*; (Spanish.) *karst de conos*; (Turkish.) *konili karst*; (Yugoslavia.) *stožasti krš, čokasti kras stožčsti, kras*. See also *cockpit karst*. Compare: *cupola karst, pinnacle karst, and tower karst*.

confined. A modifier that describes a condition in which the potentiometric surface is above the top of the aquifer^[22]. Synonymous with *artesian*.

confined aquifer. 1. An aquifer bounded above and below by confining units of distinctly lower permeability than that of the aquifer itself. 2. An aquifer containing confined ground water. Generally, a

confined aquifer is subject to pressure greater than atmospheric^[6].

confined water. Water separated from the atmosphere by impermeable rock stratum^[16].

confining bed. A body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers^[22]. Synonymous with *confining unit*.

confining unit. 1. A hydrogeologic unit of impermeable or distinctly less permeable material bounding one or more aquifers and is a general term that replaces aquitard, aquifuge, aquiclude^[22]. 2. Means a body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers^[22]. Synonymous with *confining bed*.

confining zone. A geological formation, group of formations, or part of a formation that is capable of limiting fluid movement above an injection zone^[22]. See *confining unit*.

confluence. Junction point of streams^[16].

conformal mapping. The transposition and solution of plane flow problems in a complex plane^[16].

conglomerate. Rock consisting of large well rounded waterworn particles^[16].

conical wall niche. See *meander niche*.

conjugate joints or faults. Two sets of joints or faults that are formed under the same stress conditions (usually shear pairs).

conjunctive use. The use of both surface water and ground water^[16].

connate water. Water entrapped in the interstices of a sedimentary or extrusive igneous rock at the time of its deposition^[22].

consequent river. A river flowing down the original slope of geologic beds or general slope of topography^[16].

consolidation. 1. The binding of grains by cementing material to solid matrix^[16]. 2. The gradual reduction in the water content (void ratio) of a saturated soil, as a result of an increase in the pressure acting on it, because of the addition of overlying sediments or the application of an external load. A laboratory test commonly known as a one-dimensional consolidation test (odometric test) is performed on soil samples to evaluate consolidation. From such a test, the coefficient of consolidation, c_v , usually expressed in cm^2/sec , is calculated as the ratio

$$c_v = \frac{K \cdot l}{m_v \cdot \gamma_w}$$

where K is the hydraulic conductivity, m_v is the coefficient of volume compressibility, and γ_w is the unit weight of water. The theory of consolidation leads to a relation between degree of consolidation and time:

$$U\% = \frac{c_v \cdot t}{H^2}$$

In this expression U is the degree of consolidation or the percentage of total consolidation occurring in some time t , c_v is the coefficient of consolidation, and H is

half of the sample's thickness when the odometric test is performed^[21].

consolidated rock. Rock that has become hard and coherent through compression and lithification^[16].

constructive waterfall. A large rimstone dam on a surface stream^[10]. See *rimstone dam*. Synonyms: (French.) *chute incrustante*; (German.) *Waßerfall, inkrustierender, Sinter, Sinterbecken*; (Greek.) *katarráktis*; (Italian.) (*vasche d'incrostazione*); (Spanish.) *dique travertino*; (Turkish.) *düşüm*; (Yugoslavian.) *slap, prečaga*.

consumptive use. The quantity of water used annually by crops or natural vegetation due to transpiration, tissue building, and evaporation from adjacent soil^[16].

contact load. The solid material in sliding or rolling contact with a stream bed^[16].

contact spring. See *spring, contact*.

contaminant. 1. An undesirable substance not normally present or an unusually high concentration of a naturally occurring substance in water or soil^[22]. 2. Any physical, chemical, biological, or radiological substance or matter in water^[22]. See also *pollutant*.

contaminant plume. An elongated body of ground water containing contaminants, emanating and migrating from a point source within a hydrogeologic unit(s)^[22].

contaminate. To introduce a substance that would cause (a) the concentration of that substance in the around water to exceed the maximum contaminant levels; or (b) an

increase in the concentration of that substance in the ground water where the existing concentration of that substance exceeds the maximum contaminant levels^[22]. See also *pollutant*.

contamination. The addition to water of any substance or property preventing the use or reducing the usability of the water. There is no specific limits, since the degree of permissible contamination depends upon the intended end use, or uses, of the water^[6]. Sometimes considered synonymous with *pollution*.

continuous stream. A stream that is continuous in space from source to discharge point^[16].

contributing region. That region which contributes to well discharge in inclined water-table flow^[16].

control. The combined effect of channel characteristics (area, shape, slope, roughness) on rating curve^[16].

conulite. A hollow, cone-shaped speleothem formed when a conical depression is drilled in cave mud by falling water. Subsequent erosion may remove the mud, isolating the calcite lining of the depression^[10].

convective diffusion. See *mechanical dispersion, coefficient*.

convective transport. The component of movement of heat or mass induced by thermal gradients in ground water^[22]. See also *advection*.

convection. The process whereby heat is carried along with the flowing ground water^[22].

convergence. Net horizontal inflow of moisture per unit area^[16].

cooling water. Water used only for cooling purposes^[16].

cool spring. Spring water temperature below mean annual surface temperature^[16].

coprolite. The fossilized excrement of vertebrates such as fishes, reptiles, and mammals, larger than a fecal pellet, measuring up to 20 cm in length, characterized by an ovoid to elongate form, a surface marked by annular convolutions, and a brown or black color, and often composed largely of calcium phosphate; petrified excrement^[1].

coquina. Porous limestone composed of broken shell fragments^[16].

coralloid speleothem. Any variety of microcrystalline, coralloid or botryoidal calcite deposit that is distinguished by curved outer surfaces and curved internal structures. Large examples, including clouds, are formed under water. Smaller varieties, also known as cave coral and cave popcorn, are splash deposits, or are precipitated onto cave passage walls from mists or thin surface films of saturated water^[9].

corrasion. Abrasion of the rock floor and walls of a stream channel by rock debris carried in the water^[9], or mechanical erosion performed by such moving agents as water, ice, and wind, especially when

armed with rock fragments^[10]. See also *corrosion*.

corridor. 1. Long, narrow chasm enlarged by action of water and into which surface runoff or stream may flow; may be located along a fault plane, fissure, joint or between two beds. Struga (Slavic) refers to such a corridor along a bedding plane in a carbonate formation^[20]. 2. Relatively narrow passageway permitting travel between two larger areas. 3. A fairly level and straight passage that links two or more rooms or chambers in a cave. 4. Intersecting linear depressions on the surface of the land, related to joints or dikes^[10]. See also *bogaz*; *struga*; *zanjón*. Related to chasm; bogaz. Synonyms: (French.) *gouffre absorbant*; (German.) *Karstgasse*; (Greek.) *apocheteftikos karstikos agogos*; (Italian.) *dolina allongata*; (Russian.) *coridor, hod*; (Spanish.) *callejón*; (Turkish.) *koridor*; (Yugoslavian.) *struga, bogaz*.

corrosion. 1. Chemical action of water containing carbonic acid (also humidic, nitric, and other acids) on limestones and dolomites causing partial solution and related chemical changes in the rocks^[20]. 2. Erosion by solution or chemical action^[10]. 3. The act or process of dissolving or wearing away metals^[6]. See also *accelerated corrosion*; *alluvial corrosion*; *corrasion*; *solution*. Compare *aggressive water*. Synonyms: (French.) *corrosion*; (German.) *Korrosion*; (Greek.) *chemeke thiavroses*; (Italian.) *dissoluzione, corrosione*; (Russian.) *korrozija*; (Spanish.) *corrosión*; (Turkish.) *eritme, yenme, kemirilme*; (Yugoslavian.) *korozija*.

corrosive. Property of aggressive water.

coupole. (French.) Cupola or hemispheric hill^[10].

cove. (Southern Appalachians.) Narrow steep-sided karst valley flanking limestone plateaus^[10].

covered karren. Any karren that is covered by soil. Draining water is oversaturated with respect to CO₂ so that corrosion is extensive^[3]. See also *wave karren*; *root karren*; *cavernous karren*.

covered karst. 1. A fossil or currently developing karst in karst limestone which underlies superficial deposits or other rock, and which may produce landforms at the surface which reflect subsurface karstification^[19]; contrasted with naked karst, which is soil free. See also *buried karst*; *interstratal karst*; *mantled karst*; *subsoil karst*; *sulfate-reduction karst*. 2. A generally subdued karst landscape developed where carbonate rocks are affected by dissolutional processes beneath a soil cover (see *bare karst*)^[9]. Synonyms: (French.) *karst couvert*; (German.) *Bedeckter karst*; (Greek.) *kekalymenon karst*; (Italian.) *carso coperto*; (Russian.) *pokrytyĭ karst, pokritij karst*; (Spanish.) *karst cubierto*; (Turkish.) *örtülü karst*; (Yugoslavian.) *pokriveni krš, pokriti kras*.

crack. 1. Tight joint^[16]. 2. A small fracture (i.e., small with respect to the scale of the feature in which it occurs).

crandallite. A cave mineral — $\text{CaAl}_3(\text{PO}_4)_2(\text{OH})_5 \cdot \text{H}_2\text{O}$ ^[11].

crawl, crawlway. A cave passage that is large enough to be negotiated on hands and

- knees^[10] or so small as to require a caver to squeeze through on his/her back or belly^[13].
- creek, brook.** Watercourse of lesser volume than a river.
- crenate wall niche.** See *meander niche*.
- crest line.** Line connecting crests^[16].
- crest segment.** The top part of a hydrograph^[16].
- crest-stage indicator.** A mechanical gage that preserves the indication of highest water level rise^[16].
- crevice.** Opening in a rock formation or glacier^[16].
- crevice karst.** An intricate irregular crevice system that has formed by solution widening of closely spaced joints. Crevices may be as much as 6 meters across and 20 meters deep. Especially well developed near rivers in lowland New Guinea^[10].
- critical depth.** The depth of flow in open channels when specific energy is minimum^[16].
- critical depth flume.** Venturi or Parshall flume for discharge measurements^[16].
- critical flow.** Open channel flow with Froude number equal to unity^[16]. See also *Froude number*.
- crooked hole.** Borehole deflected from the vertical^[16].
- cross bedding.** Oblique deposition of thin beds with respect to the main planes of stratification^[16].
- cross fault.** A geologic fault that is oblique or at right angles to the strike direction of the beds.
- cross section.** Vertical section of a geologic profile^[16].
- crust stone.** A fragile layer of flowstone covering portions of walls of caves; looks like a flaky crust. Found in some Kentucky caves^[10].
- cryokarst.** 1. A nonkarstic term. Land surface with closed depression (usually small and shallow) formed by alternate freezing and thawing of permafrost or ground-ice overlying different rock, including limestone. The term “cryokarst” is more common in Europe while the term “thermokarst” is used in America^[20]. 2. A karstlike periglacial, or formerly periglacial, landscape superimposed upon unconsolidated, superficial deposits. Cryokarst is characterized by small depressions or pits that develop through settlement of overlying deposits into voids formed by the melting of entrapped ice. Also known as thermokarst^[9]. Synonyms: (French.) *cryokarst, thermokarst*; (German.) *Thermokarst, Cryokarst*; (Greek.) *thermokarst*; (Italian.) *criocarsismo*; (Russian.) *temokarst, criokarst*; (Spanish.) *criokarst, thermokarst*; (Turkish.) *don karstı*; (Yugoslavian.) *toplotni krš temokarst*.
- cryptokarst.** A karst term used to describe (a) the result of subsurface removal of limestone taking place beneath permeable

loess resulting in a loss of limestone and subsequent slow subsidence of the loess without noticeable surface expression, (b) the initial effects of intergranular solution of rock when there is practically no movement of water from microcavity to microcavity, (c) the karst that develops in chalk beneath a mantle of its residual clay and chert, and (d) pockets in limestone that are filled with terra rossa or other residual material and that may be actively forming, arrested in development, or “inherited.” Because this term has been used for at least four different meanings, it is recommended that it be abandoned^[17].

crystal cave. A cave in which much of the surface of the roof, walls, and floor is covered with well-formed mineral crystals^[10].

crystal pool. In caves a pool, generally having little or no overflow, containing crystals^[10].

cueta, hogback. A nonsymmetrical ridge due to a gently dipping stratum^[16].

cueva. (Spanish.) Cave, especially one that is horizontal or nearly so^[10].

cul-de-sac; dead end. A subterranean passage having only one entry^[10].

cumulative production. The sum total of volumetric discharge of a well since production began^[16].

cupola. A hemispheric hill of limestone^[10]. See also *cone karst*; *cupola karst*; *mogote*; *pinnacle karst*; *tower karst*. Synonyms: (French.) *cupole*; (German.) *Halbkugel*.

cupola karst. A type of karst topography common in the tropics in which the residual hills rise in hemispherical or dome-capped mounds from intervening depressions or sinkholes^[20]. See also *cone karst*; *cupola*; *pinnacle karst*; *tower karst*. Synonyms: (French.) *karst à cupules*, *coupole*; (German.) *Kegelkarst*; (Greek.) *konoidhes karst*; (Italian.) *carsismo con forme residuali a cupola*; (Spanish.) *karst de cupulas*; (Turkish.) *kubbeli karst*; (Yugoslavian.) *kupolni kr̃s(kras)*.

current marking. Shallow asymmetrical hollows, caused by turbulent waterflow, that are distributed in rather regular fashion over limestone surfaces^[10]. See also *scallop*.

current meter, current counter. A device used to measure the current velocity directly at a given point^[16]. Synonym: *ammeter*.

curtain. 1. Sinuous, thin sheet (or sheets) of dripstone formed on the roof or walls of a cave or behind a waterfall^[20]. 2. A wavy or folded sheet of flowstone hanging from the roof or projecting from the wall of a cave; often translucent and resonant^[10]. See also *bacon*; *blanket*; *drapery*. Related to *helictite* and *speleothem*. Synonyms: (French.) *draperie stalagmitique*; (German.) *Sinterfahne*; (Greek.) *parapetasma stalaktitikon*; (Italian.) *cortina stalattitica*; (Russian.) *zanavesj*; (Spanish.) *bandera*, *cortina*; (Turkish.) *perde*; (Yugoslavian.) *sigasta zavjesa*, *sigasta zavesa*.

curve, backwater. A water surface profile in a stream or channel above a constriction or impoundment^[16].

curve, concentration. The rising limb on a hydrograph curve^[16].

curve, desorption. Curve of moisture content versus soil moisture tension^[16].

curve, drawdown. A plot of drawdown with radial distance from a well^[16].

curve fitting. The fitting of experimental data points to a theoretical type curve^[16].

cutter. 1. (Tennessee.) Solution crevice in limestone underlying residual phosphate deposits. 2. A karren-like groove formed beneath the soil, more commonly referred to as subsoil karren^[10]. See also *karren*.

cuttings. Rock chips loosened from the bottom of a borehole by drilling^[16].

cyanotrichite. A cave mineral — $\text{Cu}_4\text{Al}_2(\text{SO}_4)(\text{OH})_{12}\cdot 2\text{H}_2\text{O}$ ^[11].

cycle. Regular periodic occurrence of an event^[16].

D

dam. A structure across a watercourse that impounds water; may be natural or artificial^[16].

damping. The process of gradually reducing amplitude of a periodic event such as acoustic oscillations in velocity logging^[16].

dar geçit. See *aisle*.

Darcian velocity; seepage velocity. See *specific discharge*.

Darcy's law. An empirical law given as

$$Q = -KA \frac{dh}{dL}$$

which states that the average volumetric discharge of flow through a porous medium is directly proportional to the hydraulic gradient assuming that the flow is laminar and inertia can be neglected. Note: Q=discharge, K=hydraulic conductivity, A=cross-sectional area, dh/dL=gradient, and a minus sign is attached as a convention to indicate that flow occurs in the direction of decreasing head^[5].

Darcy unit. A practical unit for the measure of intrinsic permeability^[16].

Darcy-Weisbach equation. An empirical equation given as

$$Q = -A \sqrt{\frac{8Rg}{f} \frac{dh}{dL}}$$

which states that in contrast to laminar flow, the average volumetric discharge of

flow is directly proportional to the square root of the driving force and that the friction loss is equal to the hydraulic head^[5]. Note: Q=discharge, A=cross-sectional area, R=hydraulic radius of the conduit, g=gravitational acceleration, f=some friction factor, dh/dL=gradient, and I have attached a negative sign to indicate that ground-water flow occurs in the direction of decreasing head. In most instances, a negative sign is not included because it is not possible to take the square root of a negative number.

dating of cave sediments. Determination of the age of development of caves is normally impossible. Only the sediments they contain can be dated, and these must necessarily be younger than the containing passage. Geomorphological correlations may allow more accurate dating of the cave erosion. The most useful dating method in current use is based upon a knowledge of the rates of decay of radioactive isotopes of uranium to thorium in stalagmites. This technique allows measurement of ages in material up to 350,000 years old. Dating of stalagmites has confirmed that many cave ages lie beyond this range. Electron spin resonance (ESR) measures the cumulative effects of radiation that are partly a function of time and can give stalagmite ages back to about 900,000 years. Palaeomagnetism may recognize events up to 2 million years old, but a sequence of palaeomagnetically dated sediments is required to allow identification of the actual ages^[9].

datum plane. A reference level to which topographic or water levels in wells are related^[16].

daylight hole. A hole in the roof of a cave, reaching the surface^[10].

dead cave. A dry cave in which all solution and precipitation has ceased^[10].

dead end. See *cul-de-sac*.

dead water. Standing, stagnant water^[16].

debris. 1. Any material found to have been washed into a cave from some other locality. 2. Coarse rock fragments resulting from erosion and disintegration of bedrock^[16].

debris karren. These are pinnacles that form in limestones with a thin sheet structure that soon fall into smaller fragments^[3]. See also *pinnacles*.

decalcification. Removal by solution of the calcium carbonate constituents from a rock or sediment, leaving a residuum of noncalcareous material^[9, 21]. Synonyms: (French.) *décalcification*; (German.) *Lösungsrückstand (Entkalkung)*; (Greek.) *exasvestoses*; (Italian.) *decalcificazione*; (Russian.) *dekaljifikacija*; (Spanish.) *decalcificación*; (Turkish.) *karbonatın giderme*; (Yugoslavian.) *dekalifikacijâ*.

Deckenkarren. (German.) Solutional pendant features in cave ceilings^[10].

declogging. The cleaning of clogged well surface or screens^[16].

decoration. Cave features due to secondary precipitation of calcite, aragonite, gypsum, and other rarer minerals.

deep percolation. The drainage of soil water downward by gravity below the maximum effective depth of the root zone toward storage in subsurface strata^[22].

deflocculation. The breakup of flocs of gel structures by use of a thinner^[6].

deformation. Changing of form, volume, and relative position of rock masses^[16].

degradation. 1. Geological action of wearing down a surface^[16]. 2. The process of degrading water quality in an aquifer by the addition of contaminants, either naturally or artificially. 3. The process by which various chemicals are altered to form new chemicals; breakdown.

degree of cementation. The degree to which a rock has been solidified through cementation^[16].

degree of karstification. The ratio of the volume of openings to the total volume of a soluble massif, expressed as a percentage. It is the sum of the activity indices from the initiation of karstification, and so is normally applied only to carbonate rocks with little or no primary porosity^[20]. Related to corrosion and solution. Synonyms: (French.) *taux de karstification*; (German.) *Ausmass (Grad) der Verkarstung*; (Greek.) *vathmos karstikiiseos*; (Italian.) *grado di carsificazione*; (Spanish.) *grado de karstificación*; (Turkish.) *karstlaşma derecesi*; (Yugoslavian.) *stupanj krškog procesa, stopnja zakrasevanja, stepen karstifikacijê*.

degree of saturation. See *percent saturation*.

delay. The lapse time between signal emission and signal reception in seismic logging^[16].

delta. A triangular deposit of sediments at the inflow of a river into an ocean or lake^[16].

demand. The rate of draft from an aquifer or reservoir to meet a certain demand^[16].

demineralization. The removal of mineral matter from water^[16].

dendritic. Treelike pattern^[16].

dendritic drainage pattern. A drainage pattern in which the streams branch randomly in all directions and at almost any angle, resembling in plan the branching habit of certain trees. It is produced where a consequent stream receives several tributaries which in turn are fed by smaller tributaries. It is an indicative of insequent streams flowing across horizontal and homogeneous strata or complex crystalline rocks offering uniform resistance to erosion. This pattern may form on top of the land surface or below the land surface in karst aquifers with anastomoses forming the smaller tributaries.

density. The mass of water per unit volume, usually stated in grams per cubic centimeter (gm/cm^3), but may also be measured in pounds per gallon (lb/gal), pounds per cubic foot (lb/ft^3), and kilograms per cubic meter (kg/m^3 .) Density of fresh water is taken to be 1.0.

density current. A gravity-induced flow of one current through, over, or under another, owing to density differences. Factors affecting density differences include

temperature, salinity, and concentration of suspended particles.

denudation. The wearing away of overlying loose rock to top of bedrock^[16].

denuded karst. Subsoil karst or interstratal karst that has been exposed by erosion of its cover^[17]. See also *exposed karst*; *interstratal karst*; *subsoil karst*. Synonyms: (French.) *karst dénudé*; (German.) *nackter Karst*, *oberflächlicher Karst*; (Greek.) *apogymnomenon karst*; (Italian.) *carso denudato*, *carso nudo*; (Russian.) *golij karst*, *otkritij karst*; (Spanish.) *karst denudado*; (Turkish.) *belirgin karst*; (Yugoslavian.) *ogoljeli kŕs (krās)*, *goli kŕs (krās)*, *razkriti kras*.

depletion. The withdrawal of water at a greater rate than replenishment^[16].

deposition factor. The factor that describes the settling of suspended solids within pore space^[16].

depression. A small hollow in a surface^[16].

depression spring. See *spring*, *depression*.

depth gage. 1. Any device used to measure depths such as water level in wells^[16]. 2. Specific gage for measuring river stage^[16].

depth of penetration. In electrical resistivity surveys, it is the depth to which an electrical field penetrates into the subsurface as a function of electrode spacing^[16].

desalinization. The process of salt removal^[16].

desander. A device used to separate sand from well water^[16].

desert. 1. Region where precipitation is less than 10 inches per year. 2. Region where the net moisture inflow is too small to support vegetation^[16].

desiccation. The removal of moisture by evaporation or drying^[16].

desiccation crack. A crack formed in soil as a result of shrinkage to a drying volume^[16].

desorption. The reverse process of sorption^[22]. See also *sorption*.

detritus. Loose material originating from disintegrated and weathered rock^[16].

development. The act of repairing damage to the formation caused by drilling procedures and increasing the porosity and permeability of the materials surrounding the intake portion of the well^[6].

deviation. Deflection of a recording from a base line (e.g., the deviation from vertical of a borehole)^[16].

dew-point. The point at which dew formation starts for given temperature and humidity conditions^[16].

D-horizon. The zone of bedrock in a soil horizon^[16].

diagenesis. Postdepositional physical and chemical changes in sediment^[16].

diatomaceous earth. A light-colored, soft, siliceous earth composed of the shells of diatoms, a form of algae. Some deposits

are of lake origin but the largest are marine^[6].

differential water capacity. The absolute value of the rate of change of water content with soil water pressure. The water capacity at a given water content will depend on the particular desorption or adsorption curve employed. Distinction should be made between volumetric and specific water capacity^[22].

diffuse circulation; diffuse flow. Circulation of ground water in karst aquifers (or other aquifers) under conditions in which all, or almost all, openings (primary and secondary) in the karstified rock intercommunicate and are full of water but have not been selectively enlarged in specific zones by dissolution, and so no concentration of ground water occurs in restricted conduits^[9, 21]. The ground-water flow is generally slow-moving, may be laminar, and have a uniform discharge and slow response to storms. It is being replaced by the term “slow flow” because of significant confusion regarding its usage, especially when thought of in terms of porous-media flow. Synonyms: (French.) *circulation diffuse*; (German.) *Diffuse Grundwasserbewegung*; (Greek.) *thiacheomenon ydhor*; (Italian.) *circolazione carsica diffusa*; (Spanish.) *circulación saturada difusa*; (Turkish.) *yaygın dolaşım*; (Yugoslavian.) *difuzno tečenje*.

diffusion. Process whereby ionic or molecular constituents move under the influence of their kinetic activity in the direction of their concentration gradient^[22].

diffusion coefficient. See *molecular diffusion, coefficient*.

diffusion, convective. See *mechanical dispersion, coefficient*.

diffusivity, soil water. The hydraulic conductivity divided by the differential water capacity (care being taken to be consistent with units), or the flux of water per unit gradient of moisture content in the absence of other force fields^[22].

diffusivity, hydraulic. The ratio of transmissivity divided by the storage coefficient or the hydraulic conductivity divided by the specific storage^[22].

dike. 1. A wall or embankment protecting lowlands from being flooded^[16]. 2. A subsurface sheet-like igneous intrusion into bedrock fractures^[16].

Dinaric Karst. The extensive expanse of karst landscape stretching from Italy, across the whole of southern Slovenia and Croatia, into parts of south-west Bosnia and across Montenegro, ultimately extending into Albania and Greece^[9].

dip. 1. The angle between an inclined bedding plane in a rock sequence and the horizontal. The dip value includes an inclination and a direction and the two components are generally quoted in this order and in the format 10° ENE or 10° towards 025° magnetic (etc). The dip direction is down the slope. True dip is the maximum dip value of a given bedding plane; other, lesser values, obliquely down the same bedding plane, are referred to as apparent dips. The direction at rightangles to the true dip, where the dip value is zero, is known as the

strike^[9]. 2. Maximum plunge of sloping planar features (e.g., bedding, fractures) within a geological formation measured perpendicularly to the strike of the features. See also *strike; hade*.

dipmeter survey. A geophysical borehole logging method where the dip of the penetrated strata is measured^[16].

diphenyl brilliant flavine 7GFF, direct yellow 96. A yellowish dye initially developed to color tennis balls and subsequently shown to be useful in environmental tracing studies. Dye type: *Stilbene*. See also *fluorescent dyes*.

discharge. The volumetric flow of water through a given cross section^[16].

discharge area. An area in which ground water is discharged to the land surface, surface water, or atmosphere^[22].

discharge, evaporation. The direct discharge of ground water to the atmosphere by evaporation^[16].

discharge, hydraulic. The discharge of ground water through springs or wells^[16].

discharge, maximum. The maximum discharge of a river or spring during high flow conditions^[16].

discharge, natural. The discharge of water into surface water bodies or springflow^[16].

discharge hydrograph. A graph showing the discharge of water as a function of time^[16].

discharge pipe. A pipe through which a pump discharges^[16].

discharge pressure. The pressure at which a certain discharge takes place^[16].

discharge velocity. The rate of discharge of water through a porous medium per unit of total area perpendicular to the direction of flow.

disconformity. A geological unconformity between parallel beds, often with some series missing^[16].

discontinuity. 1. A point where a mathematical function becomes nondefined^[16]. 2. An unconformity in which the bedding planes above and below the break are basically parallel, indicating a significant hiatus in the orderly sequence of sedimentary rocks. 3. A surface at which seismic-wave velocities abruptly change.

discontinuity surface. Any surface across which some property for a rock mass is discontinuous. This includes fracture surfaces, weakness planes, and bedding planes, but the term should not be restricted to mechanical continuity.

dispersion. The spreading and mixing of chemical constituents in ground water caused by diffusion and mixing due to microscopic variations in velocities within and between pores^[6].

dispersion coefficient. 1. A measure of the spreading of a flowing substance because of the nature of the porous medium, with its interconnected channels distributed at random in all directions^[22]. 2. The sum of the coefficients of mechanical dispersion and molecular diffusion in a porous medium^[22].

dispersion, longitudinal. Process whereby some water molecules and solute molecules travel more rapidly than the average linear velocity and some travel more slowly, which results in spreading of the solute in the direction of the bulk flow^[22].

dispersion, mechanical. See *mechanical dispersion*.

dispersion, transverse. Spreading of the solute in directions perpendicular to the bulk flow^[22].

dispersion zone. A zone of intermixing in miscible flow or in sea water encroachment. See also *transition zone*^[16].

dispersivity. A geometric property of a porous medium that determines the dispersion characteristics of the medium by relating the components of pore velocity to the dispersion coefficient^[22].

displacement. 1. The process of replacing one fluid in a porous medium by another^[16]. 2. A change in position of a material point. See also *miscible displacement*.

disposal well. A well used for the disposal of waste into a subsurface stratum. See also *injection well*^[22].

dissociation. A chemical process that causes a molecule to split into simpler groups of atoms, or ions. For example, the water molecule (H₂O) breaks down spontaneously into H⁺ and OH⁻ ions^[6].

dissolution. See *solution*.

dissolution of limestone. The solubility of calcite (and hence of limestone) in pure

water is very low, but is vastly increased in the presence of carbon dioxide. This gas, dissolved in water to produce carbonic acid, permits dissociation of calcium carbonate, and dissolution rates and loads are therefore directly related to carbon dioxide content. This accounts for the importance to limestone dissolution of plant growth; soil water contains much more carbon dioxide than stream waters. Further dissolution occurs through mixing of saturated waters of different carbon dioxide content (see *Mischungskorrosion*), because of a nonlinear relationship between carbonate saturation and carbon dioxide content. This process is of major significance to continued dissolution within the phreas. Cold water can dissolve more carbon dioxide but, with respect to cave development, this climatic factor is overwhelmed by the higher organic activity producing more carbon dioxide in warmer environments. Loss of carbon dioxide, by diffusion into open air, causes water to precipitate calcite as speleothems. Limestone dissolution may also be achieved by organic acids or by strong acids, particularly sulphuric acid, though such effects are normally far less than that of carbon dioxide. Strong acid dissolution is probably involved in the inception of most underground drainage. Dissolution by sulphuric acid formed by oxidation of sulfide minerals or gases may be a major cave-forming process in some regions, and was largely responsible for the enlargement of Carlsbad Caverns and Lechuguilla Cave, New Mexico^[9].

dissolution zone. A laterally extensive zone where extensive dissolution of bedrock has occurred.

distortion. A change in shape of a solid body.

distribution coefficient. The quantity of the solute, chemical, or radionuclide sorbed by the solid per-unit weight of solid divided by the quantity dissolved in the water per unit volume of water^[22].

distribution, frequency. Distribution of the number of occurrences of a variate.

disturbance. In geology, any change of the original position of rocks by folding^[16].

disturbed sample. A sample disturbed with respect to its original mode of packing and sedimentation (e.g., a drill core)^[16].

divide. 1. A line connecting the highest topographic elevations or ground-water crests that separate one drainage basin from another^[16]. 2. A ridge in the water table or potentiometric surface from which the ground water represented by that surface moves away in both directions. Water in other aquifers above or below, and even in the lower part of the same aquifer, may have a potentiometric surface lacking the ridge, and so may flow past the divide. See also *ground-water divide*; *water-table divide*. Synonyms: *ground-water divide*; *ground-water ridge*; *water-table divide*. 3. (a) The line of separation, or the ridge, summit, or narrow tract of high ground, marking the boundary between two adjacent drainage basins or dividing the surface waters that flow naturally in one direction from those that flow in the opposite direction; the line forming the rim of or enclosing a drainage basin; a line across which no water flows. 3. (b) A tract of relatively high ground between two

streams; a line that follows the summit of an interfluvium^[1]. See also *drainage divide*.

DNAPL. Abbreviation for dense nonaqueous phase liquid. Liquids falling into this category have specific gravities greater than water (the specific gravity for water is usually taken to be 1), are relatively immiscible with water, and tend to migrate downwards through the vadose and phreatic zones in a relatively unimpeded manner. See also *LNAPL*; *immiscible*; *NAPL*.

dog-tooth crystal; dog-tooth spar. A variety of calcite in the form of sharp-pointed crystals^[10].

doline; sinkhole. A basin- or funnel-shaped hollow in limestone, ranging in diameter from a few meters up to a kilometer and in depth from a few to several hundred meters. Some dolines are gentle grassy hollows; others are rocky cliff-bounded basins. A distinction may be made by direct solution of the limestone surface zone (solution dolines), and those formed by collapse over a cave (collapse dolines), but it is generally not possible to establish the origin of individual examples^[10]. Solutional enlargement is either circular in plan, if there is one dominant vertical joint, or otherwise irregular if there are several, and can achieve dimensions of up to 1,000 meters in diameter and 100 meters deep. Where a karst bedrock is covered by superficial deposits, solutional enlargement permits the latter to subside into vertical fissures, creating subsidence cones or alluvial dolines, whose slopes are unstable because of the unconsolidated nature of the surface material. The bedrock remains covered in the first instance. Dolines are

also formed by large-scale subsidence caused by cave roof-collapse of near-surface caverns; in this instance, the collapse doline, the sides are clifflike and the floor composed of the irregular blocks from the fragmented roof. Cave roof collapse is considered a relatively rare phenomenon. Closed depressions receiving a stream are known as swallow holes or stream sinks. A doline that is largely dependent upon snow for solution enlargement is known as a kotlici or Schneedoline^[19]. In America most dolines are referred to as sinks or sinkholes. See also *jama*; *pit*; *ponor*; *sink*, *sinkhole*; *stream sink*; *swallet*; *swallow hole*; *sumidero*. Synonyms: (French.) *doline*; (German.) *Dolinen*, *Karsttrichter*; (Greek.) *tholene*; (Italian.) *dolina*, *pozzo naturale*; (Russian.) *karstovaja voronka*, *karstovaja kotlovina*; (Spanish.) *dolina*; (Turkish.) *düden*, *kokurdan*, *huni*; (Yugoslavian.) *vrtača*, *ponikva*, *dolac*, *do*, *duliba*, *kotlič*, *konta*.

doline lake. A small karst lake occupying a doline or closed depression in limestone. The term implies that the doline is at or near the ground-water table and in hydrological continuity with it, or that the base of the doline is sealed with an impermeable layer such as clay^[20]. See also *sinkhole pond*. Synonyms: (French.) *lac de doline*; (German.) *Dolinensee*; (Greek.) *limni dholina*; (Italian.) *lago di dolina*, *lago carsico*; (Russian.) *karstovoe ozero*; (Spanish.) *dolina laguna*, *torca laguna*; (Turkish.) *obruk gölü*; (Yugoslavian.) *krško jezero*, *kraško jezero*.

dolomite. 1. The pure mineral dolomite has the composition $\text{CaMg}(\text{CO}_3)_2$ and has properties very similar to those of calcite. The rock dolomite consists mainly of the

mineral dolomite, with subordinate calcite, and has properties very similar to those of limestone. The natural dissolution of dolomite is generally slower than that of limestone. Hence, dolomite karst is generally less well developed than limestone karst, though exceptions do occur in areas such as northwest Canada. Large, deep caves can form in dolomite, as in the Rand of South Africa^[9]. 2. A mineral composed of calcium magnesium carbonate, $\text{CaMg}(\text{CO}_3)_2$. 2. Rock chiefly composed of the mineral dolomite^[10]. Also called *dolostone*.

dolomitic limestone. A limestone containing a significant proportion of the mineral dolomite but in which calcite is more abundant (e.g., 10%-45% dolomite, 90%-55% calcite). Many dolomitic limestones originate as calcite limestone that is subsequently affected by magnesium-rich water that replaces part of the calcite with dolomite^[9].

dolomitic flour (sand). A loose mealy rock or residuum, produced by the disintegration of dolomitic limestones under the processes of karstification^[20]. Synonyms: (French.) *sable dolomitique*; (German.) *Dolomitsand*, *Dolomitasche*; (Greek.) *dholomitikon alevron*; (Spanish.) *arena dolomítica*; (Turkish.) *dolomit kumu*; (Yugoslavian.) *dolomitni pijesak, d. pesak, d. pesek*.

dolomitization. The process whereby limestone becomes dolomite by the substitution of magnesium carbonate for part of the original calcium carbonate^[10].

dome. A high shaft in a room or passage formed by solution^[13]. See also *dome pit*.

dome pit. 1. American term defined by Davis (1930): "Mammoth Cave possesses several extraordinary vertical cavities of which the arched tops are called domes and the deep bottoms are called pits. The combined name, dome pits, is here used for them." 2. A deep shaft in a cave, intersected by a passage at or near its mid-section^[20]. See *aven*. Synonyms: (French.) *évorsion*, *marmite inversée*; (German.) *Deckenkolk*; (Greek.) *vathís lákkos me thólon*; (Italian.) *marmitta inversa*; (Spanish.) *marmita inversa*; (Turkish.) *kemerli obruk*.

double brake bars. A rappel device used by cavers that consists of two carabiners with a brake bar on each and connected together with another carabiner or a metal ring^[13].

downwarping. A down bending of stratum to form a depression or syncline^[16].

drag. The resistance force of flowing fluid on a solid boundary^[16].

drainage area. A horizontal projection of an area drained by a particular river system^[16].

drainage basin. The land area from which surface runoff drains into a stream channel or system of stream channels, or to a lake, reservoir, or other body of water^[6]. In a karst setting, subsurface drainage (internal drainage) may have boundaries defined on the basis of comprehensive ground-water tracing studies. See also *ground-water basin*.

drainage density. A ratio of total channel segment length cumulated for all orders to basin area^[16].

drainage ditch. A small channel through which surface water can drain^[16].

drainage divide. The rim of a drainage basin^[16]. See also *divide*; *ground-water divide*; *water-table divide*.

drainage network. A system of streams and rivers draining a given basin^[16].

drainage pattern. A geometric arrangement of stream segments in a drainage system^[16].

drainage ratio. A ratio of runoff to precipitation^[16].

drainage system. A network of streams and tributaries^[16].

drainage well. 1. A well installed to drain surface water, storm water, or treated waste water into underground strata^[22]. 2. A water well constructed to remove subsurface water or to reduce a hydrogeologic unit's potentiometric surface^[22].

drain tile; french drain. A porous pipe used for collection of excess ground water^[16].

drapery. A thin sheet of dripstone, equivalent to curtain^[10]. See also *bacon*; *blanket*; *curtain*.

draw. A natural depression or small valley^[16].

drawdown. 1. The vertical distance the water elevation is lowered, or the reduction of the pressure head due to the removal of water^[22]. 2. The decline in potentiometric surface at a point caused by the withdrawal of water from a hydrogeologic unit^[22].

drawdown curve. A plot of drawdown with radial distance from a well^[16].

driphole. 1. Hole in rock or clay produced by fast-dripping water. 2. Hollow space surrounded by precipitated material, such as the bottom of a stalactite^[10].

dripstone. Calcium carbonate deposited from water dripping from the ceiling or wall of a cave or from the overhanging edge of a rock shelter; commonly refers to the rock in stalactites, stalagmites, and other similar speleothems; in some places composed of aragonite or gypsum^[10]. Synonyms: (French.) *concrétions*; (German.) *Tropfstein*, *Stalagmit*, *Stalaktit*; (Greek.) *stalaktitis*, *stalagmitis*; (Italian.) *concrezione*; (Russian.) *kapeljnik*; (Spanish.) *concreción (estalagmitjca o estalactítica)*; (Turkish.) *damlataşı*; (Yugoslavian.) *sige*, *smugori*. See also *flowstone*.

drowned karst. Karst topography that is submerged by a change in sea level or lake level. Synonym: karst noyé. See also *subaqueous karst*.

drowned spring. See *spring*, *drowned*.

drought. A period of moisture deficiency and absence of water for plant growth^[16].

dry cave. A cave without a running stream^[10]. See also *dead cave*.

dry hole. A hole not obtaining any production. A nonproducing well^[16].

dry valley. 1. Valley that lacks a permanent surface stream. Dry valleys are common on carbonate rocks with good primary

permeability and occur on other permeable rocks such as sandstone. Dry valleys on cavernous limestone were formed when streams flowed on the surface, either before secondary permeability and cave systems developed, or when caves were blocked by ground ice in periglacial climates. The valleys became dry when underground drains formed or were reopened, capturing first part and then all of the surface drainage^[9]. 2. A valley that lacks a surface water channel; common in the chalk of southern England^[10]. 3. Elongated recesses and valleys at the bottom of which are dolines, jamas, and caves. 4. A valley form of fluvial or periglacial origin in which surface drainage is intermittent or totally absent. Fossil, usually with steep scree slopes, it is variously identifiable as a product of nival processes or higher water tables subsequently lowered by allogenic valley^[19]. Synonyms: (French.) *vallée sèche*; (German.) *Trockental*; (Greek.) *xera kilas*; (Italian.) *valle morta, valle asciutta*; (Russian.) *suhaja dolina*; (Spanish.) *valle seco*; (Turkish.) *kuru vadi*; (Yugoslavian.) *suha dolina*.

duck; duck-under. 1. A place where water reaches the cave roof for a short distance and can be passed by quick submergence without swimming. 2. In cave diving, a longer stretch of passage where the water is so close to the roof that crawling or swimming beneath the water surface is needed to pass^[10].

dug well. A hand-excavated well^[16].

dune limestone. (Australian.) See *eolian calcarenite*.

Dupuit's assumption. A simplifying assumption for the solution of a free surface well flow problem^[16] (e.g., a water-table aquifer.) It is based on the assumption that the slope of the phreatic surface is negligibly small so that the equipotential lines are vertical and flow is essentially horizontal.

duration curve. A cumulative frequency curve of a continuous time series of hydrologic parameters^[16].

Durchgangshöhle. (German.) See *through cave*.

dye test. Determination of direction and rate of flow of streams by marking them with dye at the infiltration area and then identifying and timing the reappearance of color at lower-lying springs, in river beds, and elsewhere in a cave system^[20]. Synonyms: (French.) *coloration*; (German.) *Färbung, Färbversuch*; (Greek.) *chrostike ichnithetesis*; (Italian.) *tracciamento con colorante*; (Russian.) *method krasjascih, indikatorov*; (Spanish.) *coloración*; (Turkish.) *boya deneyi*; (Yugoslavian.) *bojenje, barvanje*. See also *tracer*.

dynamic similarity. A scaling procedure of model and prototype where the relationship of dynamic parameters is retained^[16].

dynamometer. A device used to measure the momentum force of a stream velocity^[16].

E

ebb-and-flow spring; ebbing-and-flowing well. See *spring, ebb-and-flow*.

eccentric. Adjective or noun implying abnormal shape in speleothems, such as helictites^[10].

eccentric well. A well that is not in the center of the radius of influence^[16].

eddy. A nonlaminar circulation of fluid at boundaries of flow separation^[16].

effective abstractions. The difference between total precipitation and effective precipitation^[16].

effective diameter. A 10 percentile size (i.e., 10% diameter smaller than this diameter)^[16].

effective hydraulic conductivity. See *hydraulic conductivity, effective*.

effective porosity. See *porosity, effective*.

effective precipitation. That part of precipitation that contributes entirely to direct runoff.

effective rainfall. Effective precipitation when only rainfall is involved^[16].

effective size. The 90%-retained size of a sediment as determined from a grain-size analysis; therefore, 10% of the sediment is finer and 90% coarser^[6].

effluent. 1. The discharge of water or other fluids from a spring. 2. A waste liquid discharge from a manufacturing or treatment process, in its natural state or

partially or completely treated, that discharges into the environment^[6].

effluent cave. See *outflow cave*.

effluent stream. See *gaining stream*.

elastic limit. The point on a stress/strain curve at which transition from elastic to inelastic behavior takes place.

elastic properties. The properties describing deformation of a solid^[16].

elasticity. The property of a material that allows the material to return to its original form or condition after the applied force has been removed.

electric lamp. As used in caving, generally a helmet-mounted headpiece (bulb, reflector, and lens) with a wire running to a battery carried elsewhere on the person^[13].

electro-chemical gaging. Flow measurement based on electric detection of electrolyte tracer flow^[16].

electrolyte. A chemical that dissociates into positive and negative ions when dissolved in water, increasing the electrical conductivity^[6].

elutriation. A washing process by decantation with water^[16].

embankment. A natural or artificial lateral boundary of a river^[16].

emergence. A general term for the outflowing water, for the opening or for the area of outflow of a karst spring; includes exsurgence and resurgence^[20]. Synonyms:

(French.) *émergence*; (German.) *Ausflußstelle*, *Karstquelle*; (Greek.) *piházon ýthor (or kephalari)*; (Italian.) *risorgenza*; (Russian.) *vihod karstovih vod*; (Spanish.) *fuelle*, *manantial*, *surgencia*; (Turkish.) *yüzeye erişim*; (Yugoslavian.) *krško vrelo*, *krški izvor*, *obrh*. See also *exsurgence*; *resurgence*; *rise*.

encroachment. 1. The landward advancement of saline waters into coastal aquifers^[16]. 2. The displacement of clean water by pollutants^[16].

end effect. A disturbance introduced by the inflow and outflow sections in a flow experiment^[16].

endellite. A cave mineral — $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 \cdot 2\text{H}_2\text{O}$ ^[11].

endogenic. 1. Pertaining to, or living in, the zone immediately beneath the earth's surface (see epigean and hypogean)^[9]. 2. Pertaining to geological process originating within the earth^[16].

endokarst. The part of a vertically layered karst system that is beneath the surface. Endokarst includes the full spectrum of underground voids and the dissolutional features that are present on the rock surfaces surrounding them^[9]. See also *exokarst*.

energy head. Hydraulic head plus velocity head^[16].

enthalpy. Heat content^[16].

entrance capacity. The property of a soil to allow water to infiltrate (the maximum value of this property)^[16].

entrenchment. Erosion of an existing cave floor by a freely flowing stream to form a canyon passage that is commonly narrower than the original passage. Where the stream entrenches an originally tubular phreatic passage a characteristic keyhole-shaped profile develops. Also known as *vadose entrenchment* or *incision*^[9].

entropy. The degree of thermodynamic disorder^[16].

eolian calcarenite. A terrestrial limestone formed by the cementation by carbonates of calcareous coastal dune sand. Often shorted to “eolianite.” Synonym: *dune-limestone*; *aeolianite*. Compare *beachrock*.

eolian deposit. Sediment material deposited by wind action^[16].

ephemeral stream. A stream flowing only in direct response to precipitation^[16].

epigean. Pertaining to, or living on, the surface of the earth. See *endogean* and *hypogean*.

epikarst; epikarst zone. A relatively thick (the thickness may vary significantly, but 15 to 30 meters thick is a good generalization) portion of bedrock that extends from the base of the soil zone and is characterized by extreme fracturing and enhanced solution. It is separated from the phreatic zone by an inactive, relatively waterless interval of bedrock that is locally breached by vadose percolation. Significant water storage and transport are known to occur in this zone. Synonym for *subcutaneous zone*.

epikarstic flow. See *subcutaneous flow*.

epilimnion. Upper layer of stratified water^[16].

epiphreas, epiphreatic zone. The zone in a cave system, immediately above the phreatic zone, affected morphologically and hydrologically by floods too large for the cave to absorb at once^[10].

epsomite. A cave mineral — $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ^[11].

equation of hydrologic equilibrium. A mass balance for a ground-water basin^[16].

equipotential line or surface. 1. A contour line on the potentiometric surface along which the pressure head of ground water in the aquifer is the same. Fluid flow is normal to these lines in the direction of decreasing fluid potential^[6]. 2. Line (or surface) along which the potential is constant^[22].

equivalent per million. The number of equivalent weights in a million parts per weight solution^[16].

erodible. Susceptible to erosion^[16].

erosion. 1. The general process or group of processes whereby the materials of the earth's crust are moved from one place to another by running water (including rainfall), waves and currents, glacier ice, or wind^[6]. 2. The sequence of processes of disintegration and transportation of rock material^[16].

erosion surface. The land surface resulting from the action of erosion^[16].

erosiveness. The capacity to erode^[16].

escarpment. A steep slope, often the result of faulting^[16].

estavelle. (French.) An intermittent resurgence or exurgence, active only in wet seasons. May act alternatively as a swallow hole and as a rising according to ground-water conditions^[10]. Opening in karstic terrane that acts as a discharge spring during high potentiometric surface and as a swallet during low potentiometric surface. Sea estavelles are known to exist^[20]. Synonyms: (French.) *estavelle*; (German.) *Estavelle*; (Greek.) *estavella*; (Italian.) *estavella*; (Russian.) *estavella*; (Spanish.) *estavela*; (Turkish.) *su batar çikarı*; (Yugoslavian.) *estavela, ponor-rigalo*.

esker. A stratified fluvioglacial deposit in the form of a winding ridge^[16].

etched pothole. See *solution pan*.

estuary. The lower course of a river discharging into the sea and subject to tidal currents^[16].

evaporate. A sedimentary rock formed by evaporation and precipitation of saline waters^[16].

evaporation. The changing of water from the liquid or solid states into the gaseous state through heat exchange^[16].

evaporation loss. The loss of precipitated water that is discharged to the atmosphere by evaporation^[16].

evaporation opportunity. The amount of water made available for discharge into the atmosphere^[16].

evaporation pan. An open tank used to measure evaporation^[16].

evaporation reduction. The rate control of escape of water vapor from an open surface^[16].

evaporation suppression. The complete prevention of evaporation by mechanical or physico-chemical means (e.g., monomolecular layer)^[16].

evaporite. Rock formed by precipitation of minerals from evaporating water, usually from sea water. As sea water evaporates the least soluble mineral contents precipitate first; these include calcium carbonate that is deposited as fine-grained limestone. If evaporation continues, first gypsum, then halite, and finally a number of other sulfates and chlorides are deposited^[9].

evaporativity. Evaporative power^[16].

evapotranspiration. 1. The combined loss of water from a given area and during a specified period of time, by evaporation from the land and transpiration from plants^[22]. 2. The return of water in vapor form to the atmosphere through the combined actions of evaporation, plant transpiration, and sublimation^[16].

evorsion. Mechanical erosion by whirling water that may carry sand and gravel; pothole erosion^[10]. Mechanical erosion by rotating or whirling water carrying sand, gravel, cobbles, or boulders in suspension or as bedload^[20]. Synonyms: (French.) *évorsion*; (German.) (Auswaschung), *Auskolkung*; (Greek.) *mihanikí diávrosis*; (Italian.) *evorsione*; (Spanish.) *evorsión*;

(Turkish.) *dev kazanı aşındırması*; (Yugoslavian.) *vrtiložna erozija*.

exchange capacity. 1. The amount of exchangeable ions measured in moles of ion change per kilogram of solid material at a given pH. Synonymous with *ion exchange capacity*^[22]. 2. The total ionic charge of the adsorption complex active in the adsorption of ions^[22]. See also *cation-exchange capacity*.

exhumed karst. A karstic outcrop that has been exposed by the erosion of an allochthonous cover; there is an implication that karstification (partial or complete) had preceded the removal of the cover^[20]. Mantled karst or buried karst that has been divested of its cover. It is the reexposed portion of a former landscape^[17]. See also *buried karst*; *exposed karst*; *mantled karst*. Synonyms: (French.) *karst dénudé*; (German.) *wiederaufgedeckter Karst*; (Greek.) *gymnothen karst*; (Italian.) *carso riesumato*; (Spanish.) *karst exhumado*; (Turkish.) *açık karst*; (Yugoslavian.) *ogoljeli krš (kras)*.

exogenic. Pertaining to processes on or near the surface of the earth^[16].

exokarst. All features that may be found on a surface karst landscape, ranging in size between tiny karren forms and extensive *projes*, belong to the exokarst^[9]. See also *endokarst*.

experimental basin. A basin chosen for the thorough study of hydrological phenomena^[16].

exposed karst. A general term for bare karstic rocks outcropping at the surface of

the ground. It embraces karst areas without any initial cover (naked karst) or exposed by erosion of the residuum and soil (denuded karst) or of the allochthonous cover (exhumed karst)^[20]. Karst topography in which cover is absent^[17]. Synonyms: (French.) *karst exposé*; (German.) *nackter Karst, oberflächlicher Karst, wiederaufgedeckter Karst*; (Greek.) *akalypton karst*; (Italian.) *carso denudato*; (Russian.) *golij karst, otkritij karst*; (Spanish.) *karst subaéreo*; (Turkish.) *belirgin karst*; (Yugoslavian.) *ljuti krš*. See also *denuded karst*; *exhumed karst*; *naked karst*.

extensometer. An instrument used for measuring vertical deformation of fine-grained beds in the subsoil under stress. Vertical extensometers commonly are installed when land subsidence follows ground-water withdrawal. Extensometers also are used to measure small horizontal displacements^[21].

external loads. External loads causing water level fluctuations in wells.

exurgence. 1. A term used to explain the reemergence at the surface, as a stream, of meteoric water that has fallen entirely upon and percolated through a calcareous massif^[19]. 2. A spring or seep in karstic terrane not clearly connected with swallets at a higher level. Synonyms: (French.) *exurgence*; (German.) *Karstquelle, Austrittsstelle*; (Greek.) *karstiki pighi*; (Italian.) *risorgente carsica*; (Russian.) *karstovij istočnik*; (Spanish.) *exurgencia*; (Turkish.) *yüzeyde blirme*; (Yugoslavian.) *vrelo, obrh*. See also *emergence*; *resurgence*.

F

fabric. The orientation in space of the elements composing a rock substance.

facet. See *scallop*.

facies. The lithologic appearance of a rock^[16].

facies change. The change in appearance that occurs when one lithologic unit ends and a new one is encountered.

failure. In rocks, failure means exceeding the maximum strength of a rock or exceeding the stress or strain requirement of a specific design.

fall. The gross slope of a river^[16].

false floor. A remnant of a sheet of flowstone, originally deposited on clastic sediments that were subsequently washed out from beneath. False floors may survive as a complete bridge between passage walls or just as projecting ledges. They may be thin and easily broken or thick and very strong^[9].

farangothes ipoyios thiavasis. See *aisle*.

fathometer. A water depth measuring device^[16].

fault. 1. A fracture in the earth's crust, across which relative rock movement has taken place, or continues to take place. Fault planes commonly guide vertical or subvertical shafts in caves, as well as guiding subhorizontal or oblique passages within the confines of the fault plane^[9]. 2. A fracture or fracture zone along which there has been displacement of the two

sides relative to one another parallel to the fracture^[6]. This displacement may be of a few centimeters or many kilometers. See also *joint fault set*; *joint fault system*.

fault breccia. The assemblage of broken rock fragments frequently found along faults. The fragments may vary in size from inches to feet.

fault cave. A cave developed along a fault or fault zone^[10].

fault gouge. A claylike material occurring between the walls of a fault as a result of the movement along the fault surfaces.

fault line. The intersection of a fault with the surface of the earth or any other plane of reference^[16].

fault plane. A plane on which dislocation and relative movement has taken place^[16].

fault scarp. An elevation formed by movement of blocks along a fault plane^[16].

fault zone. A zone with numerous small parallel faults^[16].

feeding tube. In karst terrane, a more or less straight and waterbearing underground gallery of regular cross-section. Synonyms: (French.) *tunnel*; (German.) *Stärnungsrohr*, *Karstgerinne*; (Greek.) *karstikos ypoyios agogos*; (Spanish.) *tubo*; (Turkish.) *akarsu mecrasi*; (Yugoslavian.) *vodonosni rov*. See also *stream tube*.

feldspars. A very common group of rock-forming minerals^[16].

fengcong; fengcong karst. (Chinese.) 1. A karst, conspicuous in China, that is identified by its clustered limestone hills. Fengcong (pronounced “fungston”), which translates as “peak cluster,” is a mature karst normally developed during long uninterrupted periods of rapid dissolution in wet tropical environments with high levels of biogenic soil carbon dioxide. The Chinese classify karst by the hill or peak density, in contrast to the Western classification by hill shape. Fengcong is almost the equivalent of cone karst; its closely packed hills are conical rather than hemispherical, with intervening dolines and disjointed valleys. The major occurrences are in Guizhou and Guangxi, in southern China. Some cones in Guangxi are so steep that they have been termed fengcong tower karst, but this concept is best avoided^[9]. 2. Tower karst characterized as peak cluster because the individual karst towers appear to be grouped together in clusters. Closed depression among the peaks are common^[4]. See also *fenglin; fungling; mogote; tower karst*.

fenglin; fenglin karst. (Chinese.) 1. A karst, conspicuous in China, that is identified by its isolated limestone hills. Fenglin (pronounced “funglin”) translates from Chinese as “peak forest,” and is distinguished from fengcong. Both fenglin and fengcong are mature karst normally developed only by long uninterrupted periods of rapid dissolution in wet tropical environments with high levels of biogenic soil carbon dioxide. The Chinese classify karst by the hill or peak density, in contrast to the Western classification by hill shape. Fenglin is therefore almost the equivalent of tower karst; its hills have very steep or vertical walls, and may have a height/width

ratio greater than four. The limestone hills rise above level, alluviated plains, and the finest fenglin karst around Yangshuo, Guangxi, in southern China, is one of the world’s most dramatic landscapes. The classification by hill density means that low residual cones scattered across a plain are also referred to as fenglin by the Chinese^[9]. 2. Tower karst characterized as peak forest because the individual towers appear as isolated groups on a plain. Dry valley networks separate individual towers^[4]. See also *fengcong; fungling; mogote; tower karst*.

ferrhanite. A cave mineral — $U_3(VO_4)_2 \cdot 6H_2O$ ^[11].

ferric oxide. Rust; hematite (Fe_2O_3)^[16].

ferrite zone. Zone of iron oxide accumulation in soil under humid climate conditions^[16].

Fickian diffusion. The spreading of solutes from regions of highest to regions of lower concentrations caused by the concentration gradient. In slow moving ground water, this is the dominant mixing process^[22].

field capacity; field moisture capacity. See specific retention.

field survey. Measurements taken in the field^[16].

field test. A test run in the field under normal field conditions^[16].

field velocity of ground water. Actual interstitial velocity of ground water^[16].

fill terrace. An elevated valley surface formed by aggregation^[16].

fine gravel. Rock aggregates of 1 - 2 mm diameter^[16].

fine sand. A silicon dioxide material with a grain diameter of 0.1 - 0.25 mm^[16].

finite difference method. A numerical method used to approximate the solution of partial differential equations^[16].

finite element method. A numerical method used to approximate the solution of partial differential equations.

firn. Compacted granular snow^[16].

firstkarren. (Austrian.) See *Rillenkarrren*.

fissure. Any discontinuity within the rock mass that is either initially open or capable of being opened by dissolution to provide a route for water movement. Fissures in this sense, applied generally in karst, therefore include the primary sedimentary bedding planes as well as tectonic faults and joints. More specifically, the term has been used to describe voids with average dimensions from 10 to 100 mm^[9] (an open joint or crack in rocks)^[16]. See also *conduit*; *fracture*.

fissure cave. A narrow vertical cave or cave passage along a fissure. Fissures widen out to become wells or *vertical shafts*^[10]. See also *vertical shaft*.

Flachkarren. (German.) See *clint*.

flank. A limb of a fold^[16].

flash flood. A relatively short but very intense flood^[16].

flattener. A cave passage, which though wide, is so low that movement is only possible in a prone position^[10]. See also *crawl*.

flexure. A bend in a stratum with one flank or limb only^[16].

flint. A concretionary form of silica, similar to chert, that occurs in chalk as tabular sheets and layers of irregularly shaped nodules. Being very hard and relatively insoluble, flint tends to stand out from chalk cliffs. Flint-rich horizons may also influence the inception of bedding-related dissolutional conduits in chalk^[9].

float gage. A device that indicates or records water levels with a float^[16].

floating pan. An evaporation pan floating in a water body with drum floats^[16].

floe calcite. Very thin film of pure calcium carbonate floating on the surface of a subterranean pool of very calm water^[10].

flood. A high river flow overtopping banks.

flood crest. The peak of a flood wave^[16].

flooding method. A recharge method by flooding a recharge area^[16].

floodmarks. The marks left on fixed objects by flood waters^[16].

flood plain. The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river and covered with water when the river overflows its banks. It is built of alluvium carried by the river during floods and

deposited in the sluggish water beyond the influence of the swiftest current^[6].

flood profile. A continuous line representing the water surface for a given rate of flow^[16].

flood water. Water that has overflowed its confines; the water of a flood^[1].

flood-water zone. See *epiphreas*.

flood wave. A rise in the stage of a stream that culminates in a crest before receding^[1].

floor pocket. See *pocket*.

flow, base. See *base flow*.

flow, creep. Flow with a creeping motion where inertial terms have been dropped^[16].

flow, critical. See *critical flow*.

flow duration curve. A curve of cumulative streamflow versus the corresponding per cent of time^[16].

flow gage. A gage used to measure flow rate^[16]. See also *gage*.

flow-mass curve. 1. A mass curve with runoff discharge as a hydrologic quantity^[16].
2. The integral of the curve of a hydrograph^[16].

flow line. The general path that a particle of water follows under laminar flow conditions^[22]. Flow lines are usually drawn perpendicular to equipotential lines. See also *equipotential lines*.

flow net. 1. A graphical representation of flow lines and equipotential lines for

two-dimensional, steady-state ground-water flow^[22]. 2. A net of orthogonal streamlines and equipotential lines applied in the graphical solution of Laplace's equation^[16].

flow path. The subsurface course a water molecule or solute would follow in a given ground-water velocity field.

flow rate. Volumetric rate of flow^[16].

flow, steady. A characteristic of a flow system where the magnitude and direction of specific discharge are constant in time at any point^[22]. See also *flow, unsteady*.

flow, uniform. A characteristic of a flow system where specific discharge has the same magnitude and direction at any point^[22].

flow, unsteady. A characteristic of a flow system where the magnitude and/or direction of the specific discharge changes with time. Synonymous with *nonsteady flow*. See also *flow, steady*.

flow velocity. See *specific discharge*.

flower. A cave flower is a group of crystals, commonly of gypsum or mirabilite, that grow by accretion at their bases on a cave wall. As the crystals grow, curve and splay, their form mimics that of a flower^[9].

flowing artesian well. A well with its potentiometric surface above the ground surface^[16].

flowmeter. An instrument for measuring volumetric flowrate^[16].

flowstone. Deposits of calcium carbonate, gypsum, and other mineral matter that have accumulated on the walls or floors of caves at places where water trickles or flows over the rock^[10]. Layered deposits of calcium carbonate precipitated on rocks from water trickling over them^[20]. (French.) *coulée stalagmitique*; (German.) *Sinterfall, Sinter*; (Greek.) *asvestolithikon epiphlioma*; (Italian.) *colata stalagmitica, deposito, concrezione, stalagmite*; (Russian.) *nateki*; (Spanish.) *colada estalagmítica*; (Turkish.) *akmataşı*; (Yugoslavian.) *kaskade*. See also *dripstone*.

fluid potential. The mechanical energy per unit mass of a fluid at any given point in space and time with regard to an arbitrary state and datum^[22].

fluorapatite. A cave mineral — $\text{Ca}_5(\text{PO}_4)_3\text{F}^{[11]}$.

fluorite. A cave mineral — $\text{CaF}_2^{[11]}$.

flume. A channel supported on or above ground^[16].

fluorescein. A reddish-yellow crystalline compound that imparts a brilliant green fluorescent color to water in very dilute solutions; used to label underground water for identification of an emergence^[10]. Also commonly known as uranine. Dye type: Xanthene.

fluorescent dyes. Material used in environmental tracing studies that may be detected and measured in small concentrations ($\approx 10^{-12}$ mg/L). Such dyes are inexpensive, relatively nontoxic, and relatively miscible with the water being traced.

flushed zone. In geophysical well logging, the zone around the well bore completely invaded by the mud filtrate^[16].

flute. See *scallop*.

fluviokarst. 1. A karst landscape where the dominant landforms are valleys cut by surface rivers. Such original surface flow may relate either to low initial permeability before caves (and hence underground drains) had developed, or to reduced permeability due to ground freezing in a periglacial environment. In both cases the valleys become dry as karst development improves underground drainage^[9]. 2. Mixed terranes characterized by both shallow karst and erosional landscape^[20]. 3. A predominantly karst landscape in which there is much evidence of past or present fluvial activity^[10]. Synonyms: (French.) *fluviokarst*; (German.) *Fluviokarst*; (Greek.) *fluviokarst*; (Italian.) *fluviocarsimo*; (Spanish.) *fluviokarst*; (Turkish.) *akarsu karstı*; (Yugoslavian.) *fluviokrš, fluviokras, fluviokarst*.

flux. See *specific discharge*.

foaming agent. See *surfactant*.

foiba. (Italian.) 1. A deep wide vertical cavity or the swallow point of a river at the beginning of its underground course. 2. A natural vertical shaft in soluble rock, tending toward cylindrical shape; it may or may not reach the surface. A dome pit^[10].

fold. A bend in a geologic stratum with two flanks, often in anticlinal and synclinal sequence.

formation. The fundamental unit in rock-stratigraphic classification, consisting of a distinctive mappable body of rock^[10]. See also *cave formation*; *speleothem*.

formation stabilizer. A sand or gravel placed in the annulus of the well between the borehole wall and the well screen to provide temporary or long-term support for the borehole^[6].

formation temperature. The prevailing temperature in a given subsurface formation^[16].

form factor. A factor indicating the shape and form of mineral aggregates influencing their hydrodynamic properties^[16].

fossil cave. A fossil cave is an underground cavity that formed when a carbonate succession was undergoing karstification but subsequently buried. Most fossil caves have been infilled by younger sediments. See *neptunian deposits*, *palaeokarst*, and *relict cave*.

fossil karst. See *paleokarst*.

fossile karst. (French.) See *buried karst*.

fouling. The process in which undesirable foreign matter accumulates in a bed of filter media or ion exchanger, clogging pores and coating surfaces and thus inhibiting or retarding the proper operation of the bed^[6].

fountain. A free-flowing well or spring^[16]. See also *artesian well*; *spring*, *artesian*.

fracture. 1. A break or secondary discontinuity in the rock mass, whether or not there has been relative movement

across it. Faults, thrusts, and joints are all fractures, but bedding planes, which are primary features, are not. In a more strictly hydrogeological context the term has been used to classify voids in the size range 0.1 to 10 mm^[9]. 2. Breakage of rock strata^[16]. 3. The general term for any mechanical discontinuity in the rock; it is, therefore, the collective term for joints, faults, cracks, etc. See also *conduit*; *fissure*.

fracture pattern. The spacial arrangement of a group of fracture surfaces.

fracture spring. See *spring*, *fracture*.

fracturing. A formation of breaks in a rock due to folding or faulting^[16].

francoanellite. A cave mineral — $\text{H}_6\text{K}_3\text{Al}_5(\text{PO}_4)_8 \cdot 13\text{H}_2\text{O}$ ^[11].

free-surface stream. In a cave, a stream that does not completely fill its passage^[10].

free water. See *gravitational water*.

free water elevation. See *water table*.

freezing point. The point at which a liquid solidifies^[16].

fresco. A half-section of a stalactite on the wall of a cave.

fresh water. Water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids; generally more than 500 mg/L is undesirable for drinking and many industrial uses^[22].

freshwater lens. 1. Body of fresh ground water found typically beneath permeable

limestone islands or peninsular land masses in the tropics. The lens-shaped water body is bounded above by a water table and below by a mixing zone between fresh and saline ground water along the halocline. In the center of the lens freshwater extends below sea level, and another set of springs exists where dissolutional conduits associated with the lower limit of the lens intersect the rock surface below sea level^[9].

2. A lenticular form of a freshwater body under oceanic coasts^[16].

friction head. Head loss due to energy dissipation by friction^[16].

Froude number. A dimensionless numerical quantity used as an index to characterize the type of flow in a hydraulic structure that has the force of gravity (as the only force producing motion) in conjunction with the resisting force of inertia. It is the ratio of inertia forces to gravity forces, and is equal to the square of a characteristic velocity (mean, surface, or maximum velocity) of the system divided by the product of a characteristic linear dimension (e.g., diameter or depth) and the gravity constant, acceleration due to gravity, all of which are expressed in consistent units in order that the combinations will be dimensionless. The number is used in open-channel flow studies or where the free surface plays an essential role in influencing motion^[1] such as in karst conduits that are not necessarily flowing at pipe-full conditions. See also *Chézy equation*; *Manning equation*; *Reynolds number*.

fullflow spring. See *spring, fullflow*.

fungling; fungling karst. (Chinese.) Isolated limestone hill in alluvial plain, probably

similar to mogote^[10]. See also *fencong*; *fenglin*; *mogote*; *tower karst*.

funicular regime. The distribution of continuous liquid phase along pore walls with gaseous phase at the pore center^[16].

G

gage well. A stilling well in which stage measurements are performed^[16].

gage station. The point at which stage measurements are performed^[16].

gaining stream. A stream or reach of a stream whose flow is being increased by inflow of ground water^[22].

galena. A cave mineral — PbS^[11].

gallery. A rather large, nearly horizontal passage in a cave^[10].

galvanometer. A sensitive current meter^[16].

gas-expansion method. The measurement of porosity based on the Boyle-Mariotte's gas laws^[16].

geo. See *blowhole*.

geochemistry. The science of the qualitative and quantitative identification of the elements and their distribution in the earth^[16].

geode. Hollow globular bodies varying in size from a few centimeters to several decimeters, coated on the interior with crystals^[10].

geodesy. The science of measuring the geometrical properties of the earth^[16].

geohydrologic system. The geohydrologic units within a geologic setting, including any recharge, discharge, interconnections between units, and any natural or man-induced processes or events that could

affect ground-water flow within or among those units^[22]. See also *ground-water system*.

geohydrologic unit. An aquifer, a confining unit, or a combination of aquifers and confining units comprising a framework for a reasonably distinct geohydrologic system^[22].

geohydrology. The branch of hydrology relating to the quantitative treatment of ground-water occurrence and flow^[16].

geological column. A vertical cross section through a sequence of formations^[16].

geological organ. A cylindrical or funnel-shaped cavity in relatively soluble bedrock that typically has a vertical orientation and is partly or wholly filled with material similar to the overlying sediment cover. They are produced by solution of bedrock and concomitant subsidence of its sedimentary cover. Most have a diameter of 25 cm to 7 m and a depth of 2 to 30 m, but some may be much larger. A depth/diameter ratio of 5 to 20 may be considered representative. In actuality, geological organs are a type of subsidence doline that develops under a cover of younger rock or sediment^[17]. Synonyms: (French.) *Orgue géologique, poche de dissolution, puits naturel*; (Belgian.) *abannet, cavité de dissolution*; (German.) *geologische Orgel, Orgel, unterirdische Doline, Verwitterungssacke, natürlicher Schacht, Erdorgel, Erdpfeife, Riesentoph, Bodenkarren*; (British.) *sand pipe, sand-gall, gravel-pipe, pipe, pocket deposit, gull*; (Italian.) *organo geologico*; (Roumanian.) *orgile geologică*; (Czech.) *geologické varhany*; (Polish.) *organy geologiczne*;

(Russian.) *organ truba, kamin*; (Serbo-Croatian.) *geološke orgulje*; (Slavic) *geološke orglje, zapolvje jaški*; (Dutch.) *geologische orgelpijp, aardpijp*.

geological section. A vertical section through a sequence of rock masses or strata^[16].

geologic control. The influence of geologic factors on hydrogeologic features^[16].

geologic correlation. The correlation of geologic formations as shown in geologic logs over a given area^[16].

geologic log. A vertical cross section of the lithologic column indicating geologic and petrographic data^[16].

geologic similarity. A model-prototype length ratio^[16].

geomorphic process. The process responsible for the formation and alteration of the earth's surface^[16].

geomorphology. The science of the origin and evolution of land forms^[16].

gestation. The gestation phase of speleogenesis follows the inception phase, and the two in combination are essentially equivalent to the more commonly used term "initiation." The transition from inception to gestation may correspond to the establishment of gravitational laminar flow conditions, and gestation is complete when turbulent flow is achieved^[9].

Ghyben-Herzberg conditions. Equilibrium condition at the interface of immiscible freshwater bodies and saltwater bodies in coastal aquifers^[16].

glacial deposit. Sedimentary deposits due to transport by glaciers^[16].

glacial drift. Sediment material contained, transported, and deposited by glaciers^[16].

glacial groove. A groove cut into bedrock by rock fragments at the bottom of a moving glacier^[16].

glacial till. An unsorted mixture of glacial drift^[16]. Synonym: *boulder clay; till*.

glaciation. A covering of the land surface by glacier ice^[16].

glacier. An extensive body of ice covering the land surface^[16].

glacier cave. 1. A cave carved out of the ice inside a glacier, not to be confused with an ice cave. Passages are formed by meltwater descending from the glacier surface via crevasses, or by melting on the glacier base. Through caves may connect sinkholes (sometimes called moulins) to glacier snout resurgences, but due to ice movement most glacier caves are ephemeral. The most extensively explored glacier caves were the Paradise Caves on Mount Rainier, USA, whose passages extended for many kilometers, before the glacier wasted away and the caves were destroyed^[9]. 2. Cave in ice formed within or at the base of a glacier^[10].

glaciofluvial. Pertaining to the meltwater streams flowing from wasting glacier ice and especially to the deposits and landforms produced by such streams^[6].

glaciokarst. 1. A karst landscape that was glaciated during the cold periods of the

Pleistocene and displays major landforms of relict glacial origin. Bare rock scars, locally with glacial striations, and limestone pavements are characteristic, due to the lack of rapid soil formation on the limestones since glacial stripping. Dolines within a glaciokarst are mostly small and immature, as are caves, except where pre-glacial passages are intercepted. Glaciokarst is almost synonymous with alpine karst, and some of the finest is developed on the high plateaus of the Calcareous Alps, south of Salzburg, Austria^[9]. 2. A glaciated limestone region possessing both glacial and karst characteristics^[10]. (French.) *karst glaciaire*; (German.) *Gebiet mit karst und Glazial-Formen*; (Greek.) *pagheto-karst*; (Spanish.) *glaciokarst*; (Turkish.) *buzul karstı*; (Yugoslavian.) *glaciokr̃s glaciokras, glaciokarst*. See also *alpine karst*; *nival karst*.

glade. 1. (Jamaican.) An elongate depression, having steep sides, in which a generally flat floor is divided into small basins separated by low divides. 2. (Tennessee.) Limestone pavement having extensive growth of cedar trees^[10]. See also *uvala*.

globularite. Small crystals of calcite tipped with spheres composed of radiating fibers^[10].

gloop. Synonym for *blow hole*. Also spelled *gloup*.

goethite. A cave mineral — $\text{FeO}(\text{OH})$ ^[11].

golyĭ karst. (Russian.) See *naked karst*.

gooseneck. The part of a winding valley resembling in plan the curved neck of a

goose. Normally found as part of an entrenched meander^[1].

gorge. A narrow passage or canyon in a mountain system^[16]. See also *canyon*.

gour. Flowstone deposit, normally of calcite, built up along the edge of a pool due to precipitation from a thin film of overflow water. Once initiated, by calcite-saturated water overflowing from floor hollows, development is self-enhancing, and the gours can grow into large dams many meters high and wide. Inside the gour pool, more calcite may be precipitated as crystals or pearls. Large flights of gours occur in many caves, with spectacular and well known examples around the Hall of Thirteen in the Gouffre Berger, France. Large travertine, gours can form in the open air, as at Band-i-Amir, Afghanistan^[9]. See also *rimstone barrage*; *rimstone barrier*; *rimstone dam*.

graben. A depression formed by a fault block moving downward on the two bounding faults^[16].

gradation. The leveling of a surface to a common level^[16].

grade. Inclination or slope^[16].

graded. An engineering term pertaining to a soil or an unconsolidated sediment consisting of particles of several or many sizes or having a uniform or equable distribution of particles from coarse to fine^[6].

gradient. The change in hydraulic head over some given distance (dh/dL) with ground-water flow usually occurring in the direction

of decreasing hydraulic head which requires by convention, the attaching of a minus sign to any equation utilizing a gradient for flow. The maximum value of the directional derivative^[16].

grain packing. The spatial arrangement of grains forming porous medium^[16].

grain per gallon (gpg.) A common basis for reporting water analyses in the water-treatment industry in the United States and Canada. One grain per U.S. gallon equals 17.12 milligrams per liter^[6].

grain shape. The geometrical aspect of grains^[16].

granular. Of structure clearly showing grain shape^[16].

granule. Small rounded grain or rock fragment^[16].

grape formation. See *botryoid*.

gravel. Waterworn rounded rock grains and fragments^[16].

gravimetric moisture content. The ratio of water weight to the weight of solid particles^[16].

gravitational head. The component of total hydraulic head related to the position of a given mass of water relative to an arbitrary datum^[22].

gravitational water. Water that moves into, through, or out of the soil or rock mass under the influence of gravity^[22].

gravity component. The component acting in the direction of gravitation^[16].

gravity drainage. The flow of water towards a well under its own weight^[16].

gravity spring. See *spring, gravity*.

grike. (British.) 1. A solutionally enlarged vertical or steeply inclined joint in the surface of a karstland, extending for up to a few meters into the limestone^[10]. 2. A vertical or subvertical cleft in a limestone pavement developed by solution along a joint or system of crisscrossing joints^[20]. Grikes separate clints from one another. Synonyms: (British.) *gryke*; (French.) *lapiaz*; (German.) *Kluftkarren*. See also *clint; bogaz; limestone pavement*.

grotto. 1. Hole in small cave or cavern that has eroded in the wall of a main cave. 2. Widely open and shallow cave within a vaulted roof. 3. A cave or chamber preceded by a narrower passage^[20]. 4. A small cave, natural or artificial. 5. A room, in a cave system, of moderate dimensions but richly decorated^[10]. A grotto is often intricately decorated, and may occur above, at, or below sealevel^[20]. Synonyms: (French.) *grotte, baume, balme*; (German.) *Höhle, Grotte*; (Greek.) *speleon*; (Italian.) *grotta*; (Russian.) *grot*; (Spanish.) *gruta*; (Turkish.) *mağarauk*; (Yugoslavian.) *niša*.

ground air. See *soil air*.

ground slope. The inclination of the land surface with the horizontal^[16].

ground water, phreatic water. 1. The part of the subsurface water that is in the phreatic zone^[10]. Its lower limits are the

zone of rock flowage or the lowest fully confining bed; its upper limits are the uppermost fully confining bed or the water table^[16]. 2. Used loosely and incorrectly by some to refer to any water beneath the surface. See also *phreas*; *phreatic water*; *phreatic zone*.

ground-water artery. A tubular body of permeable water-filled material surrounded by confining beds^[16].

ground-water barrier. Rock or artificial material that has a relatively low permeability and that occurs below the land surface, where it impedes the movement of ground water and consequently causes a pronounced difference in the potentiometric surface on opposite sides of it^[22].

ground-water basin. 1. A general term used to define a ground-water flow system that has defined boundaries and may include permeable materials that are capable of storing or furnishing a significant water supply; the basin includes both the surface area and the permeable materials beneath it^[22]. 2. The area throughout which ground water drains toward the same point; it can be larger than the accompanying surface water drainage basin if permeable layers extend outside of the topographic divide^[16]. See also *drainage basin*.

ground-water cascade. The flow of ground water over a subsurface barrier^[16].

ground-water cement. A cementing material precipitating at the water table^[16].

ground water, confined. Ground water under pressure significantly greater than atmospheric and whose upper limit is the

bottom of a confining unit^[22]. See also *confined*; *confining unit*; *confined aquifer*.

ground-water dam. A geological stratum serving as a subsurface dam^[16].

ground-water discharge. 1. Flow of water from the zone of saturation^[22]. 2. The water released from the zone of saturation^[22].

ground-water divide. 1. A ridge in the water table or other potentiometric surface from which ground water moves away in both directions normal to the ridge line^[22]. 2. A dividing line between two ground-water basins. 3. In well hydraulics, the streamline with no flow representing the boundary of the aquifer region contributing to well discharge^[16]. See also *divide*. Synonyms: *divide*; *water-table divide*.

ground-water flow. The movement of water in the zone of saturation^[22].

ground-water flux. The rate of ground-water flow per unit area of porous or fractured media measured perpendicular to the direction of flow^[22]. See also *specific discharge*.

ground-water inventory. The complete quantitative accounting for all volumes of ground water^[16].

ground-water mound. A raised area in a water table or other potentiometric surface created by ground-water recharge^[22].

ground water, perched. Unconfined ground water separated from an underlying body of ground water by an unsaturated zone. Its water table is a perched water table.

Perched ground water is held up by a perching bed whose permeability is so low that water percolating downward through it is not able to bring water in the underlying unsaturated zone above atmospheric pressure^[22]. See also *perched ground water*.

ground-water pumping. 1. Directed or oscillatory ground-water movement, along incipient fissures in the rock, that occurs due to very small but significant relative movements of the rocks themselves, maybe as a diurnal, tidal process. It may be one of the driving mechanisms of the earliest, inception, phase of speleogenesis^[9]. The pumping of a water well to provide water for drinking, irrigation, and manufacturing, but may also be conducted for dewatering purposes.

ground-water recharge. The process of water addition to the saturated zone or the volume of water added by this process^[22].

ground-water reservoir. A reservoir in the void space beneath the water table^[16].

ground-water system. A ground-water reservoir and its contained water. Also, the collective hydrodynamical and geochemical processes at work in the reservoir^[22].

ground-water table. The surface between the zone of saturation and the zone of aeration. Also, the surface of an unconfined aquifer^[6]. Synonym: *water table*.

ground-water travel time. 1. The time-required for ground water to travel between two locations^[22]. 2. The time required for a unit volume of ground water

to travel between two locations. The travel time is the length of the flow path divided by the velocity, where velocity is the average ground-water flux passing through the cross-sectional area of the geologic medium through which flow occurs, perpendicular to the flow direction, divided by the effective porosity along the flow path. If discrete segments of the flow path have different hydrologic properties, the total travel time will be the sum of the travel times for each discrete segment^[22].

ground water, unconfined. Water in an aquifer that has a water table. Synonymous with phreatic ground water^[22].

grout. A fluid mixture of cement and water (neat cement) of a consistency that can be forced through a pipe and placed where required. Various additives, such as sand, bentonite, and hydrated lime may be included in the mixture to meet certain requirements. Bentonite and water are sometimes used for grout^[6].

grout curtain. The filling of void spaces in rocks to prevent the flow of water into and through the rock; most commonly associated with dams.

grouting. The operation by which grout is placed between the casing and the sides of a well bore to a predetermined height above the bottom of the well. This secures the casing in place and excludes water and other fluids from the well bore^[6].

grünkarst. See *subsoil karst*.

gryke. See *grike*.

guano. An accumulated deposit of animal excrement. In caves it is most commonly associated with bat colonies, but cave-dwelling birds such as swifts may also contribute. Guano is abundant only in tropical regions and may be dry and powdery, or a foul, wet sludge — as in the Niah Caves of Sarawak. It is a vital food source for many troglobites. Consisting mainly of phosphates and nitrate, it is valued as a fertilizer or an ingredient of explosives and has commonly been mined. Over 100,000 tons of bat guano have been extracted from Carlsbad Caverns, USA^[9]. See also *cave guano*.

guano cave. A cave containing large amounts of guano^[13]. See also *cave guano*.

gulf. Steep-walled closed depression having a flat alluviated bottom; in some gulfs a stream flows across the bottom^[10].

gull. A widened fissure formed by land slipping along valley sides, generally where massive beds such as limestone overlie weaker rocks^[9]. See also *tectonic cave*; *windypit*.

gully. A deep erosional channel^[16].

gushing spring. See *spring*, *vauculian*.

gypsum. 1. White or colorless mineral or rock composed of hydrated calcium sulfate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. Gypsum rock is an evaporite precipitated from sea water and is therefore soluble in water and may contain dissolutional caves. Mineral gypsum is formed in some caves by reactions between the host limestone and sulfates (including sulphuric acid) derived from oxidized sulfide minerals (see pyrite). Gypsum, also

referred to as selenite, commonly occurs as transparent crystals, blades, needles, or fibers in cave clay deposits. A more spectacular form is as fibrous or curved crystals that may develop into cave flowers on cave walls and ceilings, as for example in parts of the Flint Mammoth Cave System, USA, or grow into large, hanging chandeliers, as in Lechuguilla Cave, New Mexico^[9]. 2. A mineral composed of hydrous calcium sulfate^[10], $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

gypsum cave. Both vadose and phreatic caves can form in gypsum, which is very soluble in water, but they are uncommon because gypsum rock rarely survives total dissolution in the near-surface environments associated with explorable caves. Gypsum caves certainly exist at depth within buried evaporate sequences. In areas of wet climate, gypsum caves are generally seen only if encountered by man-made excavations. In contrast, gypsum caves are more common and more extensive in areas that have experienced a long period of dominantly arid climate. The most spectacular gypsum caves are in the Podolie region of the Ukraine, where joint guided maze-cave systems are very extensive — Optimisticeskaja has around 180 km of passage^[9].

gypsum flower. See *cave flower*.

gypsum karst. A karst landscape developed on, or perhaps above, gypsum or similar evaporite rock sequences. Dissolution of gypsum by ground water in buried interstratal situations is common, and the effects of such dissolution may be expressed at the land surface in the form of subsidence depressions. There are extensive areas of gypsum karst in North America and the

Ukraine, but British examples are limited to rare caves exposed by quarrying, and subsidence depressions above dissolved gypsum beds, such as those around Ripon, Yorkshire^[9].

H

hade. The angle of inclination of a fault (or joint) plane measured relative to the vertical^[9]. See also *dip*.

Hagen-Poiseuille equation. The equation used to define the laminar flow of water in either fractures or tubes and is given as

$$Q = - \frac{w^3 b \gamma}{12 \mu} \frac{dh}{dL}$$

for laminar flow in fractures

and

$$Q = - \frac{\pi r^4 \gamma}{8 \mu} \frac{dh}{dL}$$

for laminar flow in tubes which states that the average volumetric discharge of flow through either type of opening is directly proportional to the type, shape, and dimensions of a particular pore and the hydraulic gradient^[5]. Note: Q=discharge, w=width of the fissure, b=open portion of the long dimension of the fissure, r=radius of the tube, γ and μ are the specific weight and dynamic viscosity of water respectively, dh/dL=gradient, and a minus sign is attached to the equations to indicate that flow occurs in the direction of decreasing hydraulic head.

Halbhöhle. (German.) See *rock shelter*.

Halbkugelkarst. (German.) Tropical karst topography containing dome-shaped residual hills surrounding depressions, a kind of Kegelkarst. Also called Kugelkarst^[10].

half-exposed karren. Patches of soil on otherwise bare limestone that attack the rock by means of biogenic CO₂^[3].

half-blind valley. Blind valley in which the stream overflows in floodtime when the swallow hole can not accept all the water^[10].

half tube; half-tube. 1. An inverted channel with semicircular cross section seen in cave-passage ceilings, most clearly where the ceiling is an uneroded bedding surface. The half tube originates as part of a phreatic tube guided by the bedding plane, and the lower half is subsequently removed by vadose enlargement. The presence of half tubes provides important evidence of early phreatic-cave development^[9]. 2. Trace of a tube remaining in the roof or wall of a cave^[10]. See also *tube*.

halite. The mineral form of sodium chloride (NaCl), or rock salt. Halite occurs, sometimes to considerable thicknesses, in many buried-rock successions, from which it has been extracted both by mining and by redissolving it in water pumped from and back to the surface. The existence of brine springs indicates that natural water movement occurs through buried halite sequences, presumably through voids that could be thought of as caves. Although distinctive halite (or salt) karst features are known in some arid areas, a range of features analogous to those found on karstic rocks such as limestone are unlikely to form, and less likely to be preserved, because of halite's relative weakness and very high solubility. In Britain expressions of salt karstification are limited to relatively subdued surface features. The "flashes" of the Cheshire area are hollows, sometimes

transformed into water-filled meres, formed by subsidence of overlying rocks and superficial deposits where salt has been dissolved from buried halite beds of Triassic age^[9].

hall. In a cave, a lofty chamber which is much longer than it is wide^[10]. See also *gallery*.

halocline. A locally steep salinity gradient along the interface between fresh ground water and saline ground water, such as is found at the base of the fresh-water lens common beneath many limestone islands in the tropics. Water mixing and microbial activity are important influences on dissolution along the halocline, as shown for instance in blue holes^[9].

halomorphic soil. Saline and alkali soils.

hanging blade. A blade projecting down from the ceiling^[10]. See also *blade*.

hannayite. A cave mineral — $(\text{NH}_4)_2\text{Mg}_3\text{H}_4(\text{PO}_4)_4 \cdot 8\text{H}_2\text{O}$ ^[11].

hardening. The process of induration^[16].

hardness. 1. Property of water that prevents lathering because of the presence of cations, mainly calcium and magnesium, which form insoluble soaps^[10]. 2. The sum of calcium and magnesium ions expressed as the equivalent amount of calcium carbonate (CaCO_3)^[16]. 3. The property to form insoluble salts of fatty acid (soap)^[16].

hardpan. This develops when there are secondary calcium carbonate cementations in the lower part of the soil profile^[16]. Synonym: mortar bed. See also *caliche*; *havara*; *nari*.

havara. Name given in Cyprus to a soft porous carbonate formation, up to several meters thick, found capping many formations and containing fragments and minerals derived from older rocks; it is probably a type of hardpan or caliche^[20]. See also *caliche*; *kafkalla*.

haystack hill. (Puerto Rican.) In the tropics, rounded conical hill of limestone developed as a result of solution. Term replaced by *mogote*^[10]. Synonyms: (French.) *mogote*; (German.) *Mogote*; (Italian.) *mogote*, *rilievo carsico residuo*; (Spanish.) *mogote*; (Turkish.) *konik kireçtaşı tepesi*; (Yugoslavian.) *hum*. See also *mogote*.

head. The energy contained in a water mass, produced by elevation, pressure, or velocity^[6].

head loss. That part of head energy which is lost because of friction as water flows^[6].

head, static. The height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point. The static head is the sum of the elevation head and the pressure head^[22].

head, total. The total head of a liquid at a given point is the sum of three components: (a) the elevation head, which is equal to the elevation of the point above a datum, (b) the pressure head, which is the height of a column of static water that can be supported by the static pressure at the point, and (c) the velocity head, which is the height to which the kinetic energy of the liquid is capable of lifting the liquid^[22].

head water. The upper reach of a stream^[16].

heat of condensation. The heat released in transforming a substance from its vapor to its liquid state^[16].

heat of vaporization. The heat necessary to change water from the liquid to the gaseous state^[16].

heel-print karren. See *Trittkarren*.

helictite. 1. Generally small variety of stalactitic calcite growth that is twisted and contorted with no apparent regard for gravity. Helictites form on cave walls, ceilings, and stalactites. The growth develops as seepage water loses carbon dioxide from near its tip, having been supplied to that point by capillary action through a fine central canal. The helictite shape is created by crystal lattice distortion and crystal form changes within the calcite, but what causes these is uncertain. Impurities may play a role, and rare groups of parallel growing helictites may be wind-guided^[9]. 2. Irregular, twiglike, crystalline growths with varying orientations but often in crystal continuity, formed in caves by precipitation from bicarbonate solutions^[20]. 3. A curved or angular twiglike lateral projection of calcium carbonate having a tiny central canal, found in caves^[10]. Also known as eccentric anemolite^[20]; eccentric stalactite. Synonyms: (French.) *excentrique*; (German.) *exzentrisch gekrümmter, Tropfstein, Excentriques*; (Greek.) *stalaktits akanonistos*; (Italian.) *stalattiti anomale, eccentriche*; (Spanish.) *estalactita excentrica*; (Turkish.) *düzensiz sarkıt*; (Yugoslavian.) *heliktit*. Related to *curtain, dripstone, speleothem*.

heligmite. An eccentric growing upward from a cave floor or from a shelf in a cave. A curved or angular thin stalagmite^[10].

hematite. A cave mineral — Fe_2O_3 ^[11].

hemimorphite. A cave mineral — $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$ ^[11].

heterogeneity. A characteristic of a medium in which material properties vary from point to point^[22].

heterogeneous. The unequal spacial distribution of aquifer properties^[16].

hexahydrate. A cave mineral — $\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$ ^[11].

hibbenite. A cave mineral - $\text{Zn}_7(\text{PO}_4)_4(\text{OH})_2 \cdot 7\text{H}_2\text{O}$ ^[11].

hod. See *aisle*.

holokarst. 1. Karst area with little or no surface runoff or streams; it is underlain by thick carbonate rocks and is characterized by well-developed karst surface topography from karren to poljes and extensive subsurface karst features like caves, caverns, galleries, chimneys, etc^[20]. 2. Cvijić's term for a karst area like that of the Dinaric Karst of Slovenia. Such areas have bare surfaces on thick deposits of limestone that extend below sea level, well-developed karren, dolines, uvalas, poljes, deep ponors, and extensive cave systems; they have little or no surface drainage^[10]. Synonyms: (French.) *holokarst*; (German.) *Holokarst*; (Greek.) *holokarst*; (Italian.) *olocarsismo, carsismo, maturo*; (Spanish.) *holokarst*; (Turkish.) *tam karst*; (Yugoslavian.)

potpuni krš (kras), holokarst. Contrast *causse, merokarst.*

homogeneity. A characteristic of a medium in which material properties are identical everywhere^[22].

homogeneous. The even spacial distribution of aquifer properties^[16].

homogeneous fluid. A fluid that occurs in a single phase^[16].

hook gage. A gage for the precise position measurement of liquid levels^[16].

hopeite. A cave mineral — $Zn_3(PO_4)_2 \cdot 4H_2O$ ^[11].

horst. A block having been uplifted along its boundary faults^[16].

Horton number. Expresses the relative intensity of erosion process in a drainage basin^[16].

hot-seat rappel. A method of rappelling in a cave with the rope running under one leg, up across the opposite shoulder and controlled with a hand. The friction of the rope on the body creates a lot of heat, hence its name^[13].

hoya, hoyo. (Spanish.) A very large closed depression. Used in Puerto Rico for *doline*, in Cuba for *polje*^[10].

hum. 1. Karst inselberg. Residual hill of limestone on a fairly level floor, such as the isolated hills of limestone in poljes. In some tropical areas, used loosely as synonym for mogote^[10]. 2. Yugoslavian term for an isolated residual hill on the bottom of a

polje^[20]. Synonyms: (French.) *butte témoin*; (German.) (*Karstinselberg*), *Hum*; (Greek.) *karstiki martyree lophi*; (Italian.) *testimoni carsici*; (Russian.) *karstovij ostanec*; (Spanish.) *hum*; (Turkish.) *karst adatepesi*; (Yugoslavian.) *hum*. See also *karst inselberg; mogote*.

humidity, absolute. The moisture content by weight per unit volume of air^[16].

humus-water grooves. This is a special type of meandering karren or wall karren in which the water originated in humus covering. Water originating from a humus cover has an excess of CO₂ and is therefore very aggressive and can dissolve large amounts of limestone. Thus humus-water grooves can be very deep but after approximately 2-3 meters, the grooves flatten out and continue as normal meanders or wall karren^[3]. See also *meander karren; wall karren*.

huntite. A cave mineral — $CaMg_3(CO_3)_4$ ^[11].

hydration. The act by which a substance takes up water by absorption and/or adsorption^[6].

hydraulic barrier. A general term referring to modifications of a ground-water flow system to restrict or impede movement of contaminants^[22].

hydraulic conductivity. 1. A proportionality constant relating hydraulic gradient to specific discharge, which for an isotropic medium and homogeneous fluid equals the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of

flow^[22]. 2. The volume of water that will move through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow^[22]. 3. The ability of a rock unit to conduct water under specified conditions^[10]. It is typically expressed as gpd/ft², ft/day, or m/day.

hydraulic conductivity, effective. The rate of flow of water through a porous medium that contains more than one fluid, such as water and air in the unsaturated zone, and which should be specified in terms of both the fluid type and content and the existing pressure.

hydraulic diffusivity. See *diffusivity, hydraulic*.

hydraulic discharge. The discharge of ground water through springs or wells^[16].

hydraulic fracturing. The formation of artificial fractures in rock systems around a well by high pressure fluid injections^[16].

hydraulic gradient. 1. The change in static head per unit of distance in a given direction. If not specified, the direction generally is understood to be that of the maximum rate of decrease in head^[22]. 2. Slope of the water table or potentiometric surface^[22]. 3. A change in the static pressure of ground water expressed in terms of the height of water above a datum, per unit of distance in a given direction^[22].

hydraulic head. The height above a datum plane (such as sea level) of the column of water that can be supported by the hydraulic pressure at a given point in a ground-water system. For a well, the

hydraulic head is equal to the distance between the water level in the well and the datum plane^[22].

hydraulic jump. 1. A standing surge of water passing from below critical depth in open channel flow^[16]; often occurs in caves. 2. An abrupt depth variation in rapidly varying channel flow^[16].

hydraulic profile. A vertical section of the potentiometric surface^[16].

hydraulic radius. The ratio of the filled cross-sectional area to wetted perimeter^[16].

hydrochemical facies. Distinct zones that have cation and anion concentrations of diagnostic chemical character of water solutions in hydrologic systems that are describable within defined composition categories^[22].

hydrocompaction. The process of volume decrease and density increase that occurs when moisture-deficient deposits compact as they are wetted for the first time since burial^[21]. Synonym: *shallow subsidence*.

hydrogeologic. Those factors that deal with subsurface waters and related geologic aspects of surface waters.

hydrograph, characteristic. A hydrograph based on the unit step process.

hydrodynamic dispersion. 1. The spreading (at the macroscopic level) of the solute front during transport resulting from both mechanical dispersion and molecular diffusion^[22]. 2. The dynamic dispersion of fluid particles in flow through a porous

medium due to velocity changes in the pore channels^[16].

hydrodynamic dispersion, coefficient of. See *dispersion coefficient*.

hydrogeochemistry. The geochemistry of water as related to the occurrence of subsurface water^[16].

hydrogeologic. Those factors that deal with subsurface waters and related geologic aspects of surface waters^[6].

hydrogeologic unit. 1. Any soil or rock unit or zone which by virtue of its hydraulic properties has a distinct influence on the storage or movement of ground water^[22]. 2. Means a soil or rock unit or zone which by virtue of its porosity or permeability, or lack thereof, has a distinct influence on the storage or movement of ground water^[22].

hydrogeology. The study of subsurface waters in their geological context^[16].

hydrograph. 1. A graph relating stage, flow, velocity, or other characteristics of water with respect to time^[22]. 2. A time record of stream discharge at a given cross section of the stream or of the stream surface elevation at a given point^[16].

hydrograph separation. The separation of a hydrograph into its different components to analyze flow contributions^[16].

hydrography. The geographical description of water bodies on the earth's surface^[16].

hydrologic barrier. See *barrier, hydrologic*.

hydrologic budget. The quantitative accounting of all water volumes and their changes over time for a given basin or province^[16].

hydrologic properties. Those properties of a rock that govern the entrance of water and the capacity to hold transmit, and deliver water, such as porosity, effective porosity, specific retention, permeability, and the directions of maximum and minimum permeabilities^[22].

hydrology. The study of atmospheric, surface, and subsurface waters and their connection with the water cycle^[16].

hydromagnesite. A cave mineral — $Mg_5(CO_3)_4(OH)_2 \cdot 4H_2O$ ^[11].

hydrometeorology. Meteorology dealing with water in the atmosphere^[16].

hydrometric station. A station at which there usually are a number of hydrometric measurements being performed^[16].

hydrometry. The science of water measurements^[16].

hydrophilic. Having a great affinity for water^[16].

hydrophobic. The repelling of water^[16].

hydrophyte. A plant requiring large amounts of moisture for growth^[16].

hygroscopic coefficient. The amount of absorbed water on the surface of soil particles in an atmosphere of 50% relative humidity at 25 °C^[16].

hydropic water. Condensed water at a solid surface^[16].

hydrosphere. That part of the earth that contains liquid or solid water^[16].

hydrostratigraphic unit. See *hydrogeologic unit*.

hydroxylapatite. A cave mineral — $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$ ^[11].

hydrozincite. A cave mineral — $\text{Zn}(\text{CO}_3)_2(\text{OH})_6$ ^[11].

hyetograph. A graph of rainfall intensity against time^[16].

hygrometer. Apparatus for the direct measurement of the relative humidity in the atmosphere^[16].

hygroscopic nucleus. Small solid particles around which water condensates (cloud formation)^[16].

hypolimnion. A deep layer in stratified water^[16].

hypogean. Pertaining to, or living in, regions deeper than the endogean zone. See also *epigean*.

I

ice. Crystallized water formed below the freezing point (H₂O)^[16].

ice cave. 1. Any cave in rock that is partly filled with ice. The term should not be applied to glacier caves. The ice may form in massive icicles and flows, when percolation water from unfrozen rock seeps into a cave containing freezing air drawn in from outside. This is a seasonal situation in many alpine caves, and if winter freezing exceeds summer melting the ice may become permanent, as in Austria's Dachstein and Eisriesenwelt caves. Alternatively water vapor may crystallize out as hoar frost, commonly forming large hexagonal ice crystals that line the walls of a freezing cave, as in Grotte Valerie, northern Canada^[9]. 2. A cave, generally in lava or limestone, in which the average temperature is below 0°C., and which ordinarily contains perennial ice. Ice may have the form of stalactites, stalagmites, or flowstone^[10]. (French.) *glacière*; (German.) *Eishöhle*; (Greek.) *paghoménon spíleon*; (Italian.) *ghiacciata naturale, grotta ghiacciata*; (Russian.) *ledjanaja pescera*; (Spanish.) *cueva helada, cueva de hielo*; (Turkish.) *buz mağarası*; (Yugoslavian.) *ledena pečina, ledenjāca, ledena jama*. See *glacier cave*.

illite. A clay mineral.

imbibition. 1. The absorption of a fluid, usually water, by a granular rock or other porous material, under the force of capillary attraction, and in the presence of pressure. 2. Fluid displacement in porous media as a result of capillary forces only^[16]. 3.

Absorption of water by plants. Synonym: *capillary percolation*.

immiscible. 1. Two or more liquids that are not readily soluble^[22]. 2. The chemical property of two or more phases that, at mutual equilibrium, cannot dissolve completely in one another, e.g., oil and water^[22]. 3. The quality of liquids exhibiting a clear interface where they are in contact; not miscible^[16].

impermeable. A characteristic of some geologic materials that limits their ability to transmit significant quantities of water under the pressure differences ordinarily found in the subsurface^[22].

impervious. Not permitting the flow of water^[16].

impervious lens. An impermeable, lens-shaped body of sediment in an otherwise permeable aquifer^[16].

imported water. Water coming from outside the ground-water basin under consideration^[16].

impound. The collecting of water by damming^[16].

inception. The earliest stage of speleogenesis. The start of the inception phase marks the transition from "rock with no caves" (in the widest sense) to "rock with caves," and extends through whatever time interval is required for gravitational laminar flow conditions to be established in a given situation (see *gestation* and *initiation*)^[9].

inception horizon. A part of a rock succession that is particularly susceptible to

the effects of the earliest cave-forming processes and hence is critical to the origin of most nontectonic caves. By virtue of physical, lithological, or chemical deviation from the predominant carbonate facies within the sequence, it passively or actively favors the localized inception of dissolutional activity^[9]. See also *inception*.

incision. See *entrenchment*.

initiation. The early parts of speleogenesis, generally up to the point of breakthrough from laminar to turbulent flow, at an average conduit diameter of 10 mm. Initiation includes, but is not the same as, inception^[9].

inclinometer. An instrument to measure the inclination of surfaces^[16].

incoherent material. Unconsolidated material^[16].

incrustation. 1. Deposition of a crust (of calcite, etc.) upon an object by precipitation from water oversaturated with salts (calcium bicarbonate, etc.)^[20]. 2. The deposition of mineral matter by water^[16]. Synonyms: (French.) *incrustation*; (German.) *Krustenbildung*; (Greek.) *epiphlioma*; (Italian.) *incrostazione*; (Russian.) *obrazovanie natecnih kor*; (Spanish.) *incrustación*; (Turkish.) *kabuk bağlama*, *kabuklaşma*; (Yugoslavian.) *inkrustacija*.

induced activity. The activity or response of a system that has been subjected to an artificial excitation^[16].

induced infiltration. An increase in infiltration from a surface water body by the lowering of the original water table^[16].

induced recharge. A method of withdrawing ground water at strategic points to induce natural recharge^[16].

indurated rock. A rock that has been hardened and solidified by diagenetic processes^[16].

infiltrability. The ease of infiltration^[16].

infiltration. The downward entry of water into the soil or rock^[22].

infiltration basin. A basin in which water is spread for recharge.

infiltration capacity. The maximum rate at which a soil or rock is capable of absorbing water or limiting infiltration^[22].

infiltration gallery. A horizontal conduit for the purpose of intercepting ground water^[16].

infiltration index. The average rate of infiltration throughout a given rain storm^[16].

infiltration rate. 1. The rate at which a soil or rock under specified conditions absorbs falling rain, melting snow, or surface water, expressed in depth of water per unit time^[22]. 2. A characteristic describing the maximum rate at which water can enter the soil or rock, under specified conditions, including the presence of an excess of water. It has the dimensions of velocity^[22].

infiltrometer. Apparatus for measuring the amount of infiltration^[16].

inflow cave, influent cave. Cave into which a stream flows or formerly entered^[10].

influential stream. See *losing stream*.

initial abstraction. The maximum amount of rainfall absorbed without producing runoff^[16].

inject, to. 1. The introduction of pressurized fluids into a porous subsurface formation^[16].
2. The introduction of tracer materials (e.g., fluorescent dyes) into the subsurface.

injection head. A swivel head connector through which drilling fluid is injected into the drill pipe^[16].

injection well. Well used for emplacing fluids into the subsurface^[22].

injection zone. A geological “formation,” group of formations, or part of a formation receiving fluids through a well.

injectivity. The capacity of a well or formation to accommodate pumped-in liquid^[16].

inlet cave. A cave developed beneath a swallow hole where a surface watercourse first passes underground in karst limestone^[19].

input point. Points where water enters an underground drainage route or aquifer. An obvious type of input point is a surface sink or swallow hole, where allogenic drainage has direct access to a conduit system within a carbonate aquifer. Less obvious are points where drainage enters a potential carbonate conduit-system from adjacent noncarbonate strata (such as a porous

sandstone aquifer) or where water utilizes a fracture system to pass through otherwise relatively impermeable beds and into the carbonate aquifer^[9].

in-situ density. The density of water measured at its actual depth^[22]. See also *potential density*.

insulated stream. A stream neither receiving nor abstracting water from a ground-water body because of an impermeable bed^[16].

insurgence. A term proposed to describe a point of inflow for surface water into subsurface conduits. It has not gained wide usage and is not recommended for use. Diffuse insurgence may be used to describe the slow percolation of water through overburden and tight pores in the rock. Confluent insurgence may be applied to water entering the rock via identifiable streams sinking into the subsurface while a confluent insurgence complex would apply to a cluster of insurgences. Abandoned insurgences is the term applied to inflow points no longer used by infiltrating water. An overflow insurgence is the term used to describe insurgences utilized only during periods of high flow^[12].

intake area, recharge area. The surface area in which water is absorbed into an aquifer, eventually to reach the zone of saturation^[10].

interaquifer flow. The flow that occurs between aquifers through fracture openings or through the wellbore^[16].

interbedded. Pertaining to beds or sedimentary material intercalated in a parallel fashion into a main stratum^[16].

interbedding. A bed between layers of different material^[16].

interception. The abstraction of direct rainfall on vegetation cover^[16].

interception loss. That part of rainfall retained by the aerial portion of vegetative cover^[16].

interdigitation. The lateral interlocking of sedimentary series^[16].

interface. 1. The contact zone between two materials of different chemical or physical composition^[22]. 2. The contact plane of two immiscible liquids^[16].

interference. The condition occurring when the area of influence of a water well comes into contact with or overlaps that of a neighboring well, as when two wells are pumping from the same aquifer or are located near each other^[6].

interflow. Subsurface runoff^[16].

intergranular stress. The stress between grains in a solid matrix^[16].

intergranular voids. Generally primary or secondarily enhanced voids within rocks, with average dimensions of 0.001 to 0.1 mm. Such voids, or pores, may provide interconnected porosity in many karst rocks and allow early water movement under laminar flow conditions^[9].

intermittent spring. See *spring, intermittent*.

intermittent stream, intermittent river. 1. A stream or river that flows only in direct response to precipitation or to intermittent

discharge of a spring; not confined to karst areas, but not uncommon in them^[20]. 2. A stream or river that flows at irregular intervals^[16]. Synonyms: (French.) *cours d'eau intermittent*; (German.) *intermittierender Fluss, episodischer periodischer Fluss*; (Greek.) *dialípon potamós*; (Italian.) *torrente intermittente*; (Spanish.) *corriente intermitente*; (Turkish.) *kesintili akarsu*; (Yugoslavian.) *suš ica, suvaja*. Contrast with *interrupted river*.

intermontane basin. A basin lying between two mountain ranges^[16].

internal drainage. Drainage in a closed basin and not reaching the sea^[16]. It is common in maturely karsted terranes where surface water bodies are relatively nonexistent.

interrupted river, interrupted stream. 1. A river that flows for part of its course on the surface, and part underground in caves^[20]. 2. A stream interrupted over space^[16]. 3. A discontinuous stream^[16]. Synonyms: (French.) *rivière interrompue*; (German.) *periodischer Fluss, Karstfluss, versickernder Fluss*; (Greek.) *thiakekoménos potamós*; (Russian.) *peresihachaj reka, syhaja reka*; (Spanish.) *rio sumente*; (Turkish.) *yer yer akan nehir*; (Yugoslavian.) *sušica, suvaja, periodička rijeka (reka)*. See also *lost river; intermittent stream*.

interstice. 1. An opening in a rock or soil that is not occupied by solid matter^[22]. 2. An opening or space that may be occupied by air, water, or other gaseous or liquid material^[22]. Synonymous with *void, pore*. See also *pore; pore space; porosity; porosity, effective; porosity, primary; porosity, secondary*.

interstitial ice. Ice occurring below the surface in soil pores^[16].

interstitial water. Water held in small wedge like interstices at grain contact^[16].

interstratal karst; interstratal karstification. 1. Features formed by the dissolutional removal of all or part of a buried rock unit. Interstratal-karst features are common within highly soluble evaporite rocks such as gypsum and halite, and may be equally common, but less readily recognized, within the preserved remnants of carbonate successions. Interstratal karst should not be confused with buried karst. The finest interstratal karst in Britain is the extensive cave development in the limestones beneath the Namurian Millstone Grit plateaux of South Wales, where the large collapse dolines in the Millstone Grit are interstratal-karst landforms^[9]. 2. The process of karstification of highly soluble rocks (e.g., gypsum, anhydrite, and salt) that are overlain by less soluble rocks (e.g., shales), but are still selectively dissolved by circulating ground water^[10].

interstratal karst. Karst topography that is covered by and developed beneath pre-karst rock or sediment and may or may not be part of the contemporary landscape. It is younger than its cover and is formed by the solution of soluble rock in the subsurface, most commonly beneath relatively insoluble rock such as sandstone or chert. The term refers to areal solution rather than to cave development but is also applicable to rejuvenated mantled karst and rejuvenated buried karst. Subsoil karst is transitional to interstratal karst^[17]. Synonyms: (French.) *karst sous-jacent*; (German.) *unterirdisches Karstphänomen*; (Greek.) *kalyménon karst*;

(Italian.) *carso coperto*; (Spanish.) *karst interstradal*; (Turkish.) *tabakalar arası karst*. See also *buried karst*; *denuded karst*; *covered karst*.

inter-permafrost karst. See *permafrost karst*; *sub-permafrost karst*.

intrinsic permeability. See *permeability, intrinsic*.

inundation. The covering of an area by flood waters^[16].

invaded zone. In geophysical well logging, the zone in which an appreciable amount of mud filtrate has penetrated^[16].

invasion. In geophysical well logging, the penetration of a fluid into the porous medium^[16].

invasion depth. The depth to which drilling mud filtrate penetrates into a formation^[16].

inverted siphon. See *water trap*.

ion. An element or compound that has gained or lost an electron so that it is no longer neutral electrically and now carries a charge^[6].

ion mobility. The ease with which ions move in an electrolytical solution^[16].

irreducible saturation. The lowest water saturation obtainable by mechanical reduction methods^[16].

irrigation. The artificial watering of fields for crop production^[16].

irrigation requirement. The water needed for crop production exclusive of precipitation^[16].

irrigation return flow. The part of artificially applied water that is not consumed by evapotranspiration and that migrates to an aquifer or surface water body^[22].

irrotation flow. Potential flow or flow with no rotational component^[16].

isobath. A line of equal depth^[16].

isochrone. A line connecting water levels in observation wells for a given instant in time^[16].

isohyet. A line of equal rainfall^[16].

isopiestic line. A contour on a piezometric surface connecting points of equal static level^[16].

isopleth. A line of equal distance from the point of outflow of a basin^[16].

isopotial line. A line of equal infiltration capacity^[16].

isotherm. A line of equal temperatures^[16].

isotope tracer. Tracer that is an isotope of an element present in the water; it may be artificial (added to water) or natural (present in the water)^[20]. Synonyms: (French.) *traceur isotopique*; (German.) *Markierung durch radioaktive Isotopen*; (Greek.) *isotopicos ichnithetis*; (Italian.) *tracciante isotopico*; (Russian.) *izotopnij indikator*; (Spanish.) *trazador isotópico*; (Turkish.) *izotop izleyicisi*; (Yugoslavian.) *izotopni traser*.

isotropic. Equal properties in all directions.

isotropic mass. A mass having the same property or properties in all directions^[22].

isotropy. The condition in which the property or properties of interest are the same in all directions^[22].

izdan. A general Yugoslavian term for a ground-water reservoir from which ground water may readily be extracted; it is not specifically a karst term^[20].

J

jama. 1. (Slavic.) Vertical or steeply inclined shaft in limestone, known as abîme or aven in France and as pothole in England. 2. Any cave^[10]. Synonyms: (French.) *jama*; (German.) *Abgrund*, *Schacht*, *Schlund*; (Greek.) *karstikon phrear*; (Italian.) *abisso*, *foiba*, *pozzo*, *voragine*; (Russian.) *karstovij kolodec*, *karstovaja sahta*; (Spanish.) *sima*, *pozo*, *avenc*; (Turkish.) *obruk*; (Yugoslavian.) *bezdan*, *japaga*, *zvekara*, *peknel*, *brezno*, *prepad*, *propast*. Related to *cenote*, *doline*, *obruk*, *pit*, *shaft*, *shake hole*.

jarosite. A cave mineral — $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$ ^[11].

joint. 1. A break of geological origin in the continuity of a body of rock occurring either singly, or more frequently in a set or system, but not attended by a visible movement parallel to the surface of the discontinuity. 2. A junction or connection of mechanical elements such as drill pipe^[16]. See also *fracture*.

joint diagram. A diagram constructed by accurately plotting the strike and dip of joints to illustrate the geometrical relationship of the joints within a specified area of geologic investigation.

joint or fault set. A group of more or less parallel joints or faults.

joint or fault system. A system consisting of two or more joint or fault sets or any group of joints or faults with a characteristic pattern (e.g., radiating, concentric, etc.).

joint pattern. A group of joints that form a characteristic geometrical relationship, and

that can vary considerably from one location to another within the same geologic formation.

joint-plane cave. A cavity high in relation to width developed along steeply dipping joint planes^[10].

juvenile water. Water that has not been part of the hydrosphere before and is derived from the earth's interior^[16].

K

kafkalla. A term used in Cyprus for the hardened upper portion of crust of havara^[20]. See also *caliche*; *havara*.

kame. A stratified glacial sand and gravel deposit forming a small, conical hill^[16].

Kamenica, Kamenitza. (German, possibly of Slavic origin; plural, Kamenice.) A small depression (a few meters in diameter and several centimeters deep) in a level calcareous surface, enlarged by the solution effect of water collecting between slight undulations. It is developed vertically at first by stagnant water; the steep sides thus evolved then induce the flow of water, which flutes the slope and so eventually widens the basin. Sediments and low orders of plant life frequently collect on the even floor, the latter aiding further solution by reactivating the pH of the water^[19]. Synonyms: (French.) *kamenice*; (German.) *Opferkessel*; (Greek.) *lakouva, ythrolakkos*; (Russian.) *bljudoe*; (Spanish.) *cuenco, tinajita*; (Turkish.) *erime tavası*; (Yugoslavian.) *kamenica, skalne kotlice, scalba, skalnica*. See also *solution pan*; *water pot*.

kankar; kunkar. (Australian.) See *caliche*.

Kannelierungen. (German.) See *Rillenkarren*.

kaolin. A common clay mineral^[16].

Karren. (German.) Channels or furrows, caused by solution on massive bare limestone surfaces; they vary in depth from a few millimeters to more than a meter and are separated by ridges. In modern usage,

the terms are general, describing the total complex of superficial solution forms found on compact pure limestone. Classified into several kinds, the most common of which are: *Rillenkarren* - shallow channels separated by sharp ridges 2-3 centimeters apart; *Rinnenkarren* - flat-bottomed grooves several centimeters apart; *Kluftkarren* - joints enlarged by solution; *Spitzkarren* - large deep grooves extending down from steep spires or pinnacles; meandering karren (*Mäanderkarren*) - small winding or meandering channels; round karren (*Rundkarren*) - karren having rounded channels and intervening rounded ridges, probably reexhumed after formation under soil or peat; *Flachkarren* - equivalent to the English clint; *Bodenkarren* - karren formed beneath the soil^[10]. Synonyms: (French.) *lapiés*; (German.) *Karren, Schratten*; (Greek.) *thaktyloglyphae, amaxotrochiae*; (Italian.) *campo solcato*; (Russian.) *karri*; (Spanish.) *lapias*; (Turkish.) *erime oluğu*; (Yugoslavian.) *škrape, škripovi, grižine, žlebici, škraplje*.

Karren, free. Bare karst; water flows unhindered over the limestone surface^[3].

Karrenfeld; Karren field. (German.) An area of limestone dominated by karren^[10]. These appear as bare karst and consist of the sum of exposed and half-exposed karren, occasionally also of covered karren that have become exposed. They range in size from a few hectares to a few hundred square kilometers^[3]. Synonym: (Turkish.) *erime oluğu alanı*. See also *clint*; *grike*.

karst. (Internationally used term, originally the German form of the Slavic word “kras” or “krš,” meaning a bleak waterless place; it is the German name for a district east of

Trieste having such terrane.) A terrane, generally underlain by limestone or dolomite, in which the topography is chiefly formed by the dissolving of rock, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves^[10]. The term karst unites specific morphological and hydrological features in soluble (mostly carbonate) rocks. Morphological features include karren, dolinas (sinkholes), jamas, ponors, uvalas, poljes, caves, caverns, etc. Hydrological features include basins of closed drainage, lost rivers, estavelles, vauclusian springs, submarine springs, more or less individualized underground streams, and incongruity of surface and underground divides. Karst is understood to be the result of natural processes in and on the earth's crust caused by solution and leaching of limestones, dolomites, gypsum, halite, and other soluble rocks^[20]. Synonyms: (French.) *karst*; (German.) *Karst*; (Greek.) *karst*; (Italian.) *carso*, *carsismo*; (Russian.) *karst*; (Spanish.) *karst*; (Turkish.) *karst*; (Yugoslavian.) *krš*, *kras*. See also *buried karst*; *cone karst*; *covered karst*; *exhumed karst*; *Halbkugelkarst*; *Holokarst*; *Kegelkarst*; *Merokarst*; *microkarst*; *naked karst*; *paleokarst*; *pseudokarst*; *relict karst*; *Spitzkegelkarst*; *subjacent karst*; *syngenetic karst*; *thermokarst*; *tower karst*.

karst aquifer. See *aquifer*, *karst*.

karst barré. (French.) 1. A karst terrane of limited area completely surrounded by rocks of low permeability^[10]. 2. Term for karst areas whose lower part is enclosed and bordered by more or less impervious rocks which impedes ground-water flow out of the karst area. Synonyms: (French.) *karst barré*; (German.) *Riegelkarst*;

(Greek.) *phragmenon karst*; (Spanish.) *karst cerrado*; (Turkish.) *setli karst*; (Yugoslavian.) *zagaceni krš(kras)*, *zajezeni kras*.

karst base level. Level below which karstification does not or has not taken place^[10]. Synonyms: *base level of karstification*^[20]; (French.) *niveau de base karstique*; (German.) *Korrosionsniveau*; (Greek.) *basis apokarstoseos*, or better “*patoma apokarstoseos*”; (Italian.) *livello di base della attività carsica*; (Spanish.) *nivel de base kárstico*; (Turkish.) *karstlaşma tabani*; (Russian.) *bazis karsta*; (Yugoslavian.) *baza krškog procesa*, *baza karstifikacije*, *baza zakrasevanja*.

karst breccia. See *collapse breccia*; *solution breccia*.

karst bridge. A natural bridge or arch in limestone^[10].

karst couvert. (French.) See *covered karst*.

karst fens. 1. Marshes developed in sinkhole terrain; swampy solution fens^[10]. 2. Marsh or swamp formed by plants overgrowing a karst lake or seepage. Synonyms: (French.) *marais karstique*; (German.) *Karstsumpf*; (Greek.) *karstikon elos*; (Italian.) *palude o acquitrinio carsico*; (Russian.) *karstovoje boloto*; (Spanish.) *laguna karstica*; (Turkish.) *karst bataklıđı*; (Yugoslavian.) *lokva*, *kal*.

karst fenster. See *karst window*.

karst fossile. (French.) See *buried karst*.

karst hydrology. 1. The branch of hydrology dealing with hydrological phenomena on

and in regions and areas composed totally or in part of rocks that are soluble in water, such as limestones, dolomites, gypsum, and halite^[20]. 2. The drainage phenomena of karstified limestones, dolomites, and other slowly soluble rocks^[10]. Synonyms: (French.) *hydrologie karstique*; (German.) *Hydrologie des Karsts*; (Greek.) *karstike hydrologia*; (Italian.) *idrologia carsica*; (Russian.) *gidrologija karsta*; (Spanish.) *hidrología kárstica*; (Turkish.) *karst hidrolojisi*; (Yugoslavian.) *krška (kraska) hidrologijâ*.

karst inselberg. A residual hill of soluble rock in a polje^[20]. Synonyms: (French.) *inselberg karstique*; (German.) *Karstinselberg (Hum, Mogote)*; (Greek.) *karstiki martyres lophi*; (Italian.) *rilievo carsico residuo*; (Russian.) *karstovij ostanec*; (Spanish.) *relieve kástico residual*; (Turkish.) *karst tepesi*; (Yugoslavian.) *hum*.

karst lake. 1. Lakes on karst surface, frequently connected with ground water; lakes in subterranean hollows (caves and caverns)^[20]. 2. A large area of standing water in extensive closed depression in limestone^[10]. Synonyms: (French.) *lac de karst*; (German.) *Karstsee*; (Greek.) *karstiki limni*; (Italian.) *lago carsico*; (Russian.) *karstovoe ozero*; (Spanish.) *lago kárstico*; (Turkish.) *karstik gölü*; (Yugoslavian.) *krško (krasko) jezero*.

karst margin plain. A plain generally on limestone between higher country of limestone on one side and of less pervious rocks on the other, but having a cover of impervious detritus, which allows surface drainage^[10].

karst noyé. (French.) See *drowned karst*.

karst nu. (French.) See *exposed karst*.

karst plain. 1. Large flat surface in karst formed by erosion and corrosion^[20]. 2. A plain on which closed depressions, subterranean drainage, and other karst features may be developed. Also called “karst plateau”^[10]. Synonyms: (French.) *plateau karstique*; (German.) *Karstebene, Karstrandebene, Korrosionsfläche*; (Greek.) *karstikon pedhion*; (Italian.) *piano carsico*; (Russian.) *karstovaja ravnina*; (Spanish.) *llanura kárstica*; (Turkish.) *karst ovası*; (Yugoslavian.) *krška zaravan, površ, kraški ravnik*. See also *marginal polje*.

karst polje. See *polje*.

karst pond. Closed depression in a karst area containing standing water^[10].

karst river. 1. A river (or stream) flowing in a karstic area, either on the surface of the ground or through an underground cave system^[20]. 2. A river that originates from a karst spring^[10]. Synonyms: (French.) *rivière karstique*; (German.) *Karstfluss*; (Greek.) *karstikós potamós*; (Italian.) *corso d’acqua carsico*; (Russian.) *karstovaja reka*; (Spanish.) *río kárstico*; (Turkish.) *karst nehiri*; (Yugoslavian.) *krška rijeka, kraska reka*.

karst seep. Place where karst ground water oozes out at the surface of the ground; sometimes overgrown and then forming a karst fen^[20]. Synonyms: (French.) *suitement karstique*; (German.) *Karstgrundwasser-Austritt*; (Greek.) *karstiki thiaroi*; (Russian.) *visacivanie karstovih vod*; (Spanish.) *zona de absorción*; (Turkish.) *karst sızıntısı*; (Yugoslavian.) *močilo*.

karst shaft. A vertical or steeply sided natural opening a few tens to a few hundred meters deep, formed by solution or erosion of vertical or subvertical fractures or fissures by downflowing surface water. Such a pit, formed from above, may connect with a chimney formed from below. Synonyms: (French.) *karst shaft*; (German.) *Schacht, Schaft*; (Greek.) *karstikós lákkos*; (Italian.) *voragine, inghiottitoio*; (Russian.) *karstovaja sahta*; (Spanish.) *sima*; (Turkish.) *karst bacası*; (Yugoslavian.) *jama*. Related to *dolina, jama, obruk, pit*.

karst sous-jacent. (French.) See *interstratal karst*.

karst spring. See *spring, karst*.

karst topography. Topography dominated by features of solutional origin^[10]. Geomorphically, the dominant features usually but not always obviously present are sinkholes and caves. In tropical regions, karst towers (e.g., mogotes) may also dominate the landscape.

karst valley. 1. Valleys in karst are normally distinctive because of the lack of integrated surface drainage. Most are either blind (due to being closed where the drainage sinks underground), headless or pocket (where a river emerges from a spring), or dry (where surface flow has been lost through underground capture). The exception is the allogenic valley, where a river completely traverses a karst, normally because underground conduits at or below valley floor level are immature. Fine examples of allogenic karst valleys are Dove Dale in the Peak District and France's Tarn Gorge^[9]. 2. Elongated solution valley in limestone^[20]. 3. Valley produced by

collapse of a cavern roof^[10]. Synonyms: (French.) *vallée karstique*; (German.) *Karsttal, Karstgasse*; (Greek.) *Karstikí kilás*; (Italian.) *valle carsica*; (Russian.) *karstovaja dolina*; (Spanish.) *valle kárstico*; (Turkish.) *karst vadisi*; (Yugoslavian.) *krška (kraska) dolina*.

karst vert. See *subsoil karst*.

karst water. Water discharged from karst springs that possesses characteristics, primarily that of calcium content, indicating solution during the passage of that water across and through karst limestone. That part of karst spring water which is derived from watercourses sinking into the rock (and therefore originates mainly on impermeable rock) is said to be allogenic; that which derives from precipitation over the karst area alone is said to be autochthonous - the distinction between resurgence and exurgence waters^[19].

karst well. Term applied to features that result from the solution enlargement and rounding of joints (grikes) to produce cylindrical pits^[8]. See also *grike; joint*.

karst window. 1. Depression revealing a part of a subterranean river flowing across its floor, or an unroofed part of a cave. 2. A small natural bridge or arch that can be seen through^[10]. 3. A through opening in natural limestone walls, formed by the joining of karst grottos as a result of dissolution processes^[20]. Synonyms: (French.) *fenêtre karstique*; (German.) *Karstfenster*; (Greek.) *karstikon parathyron*; (Italian.) *finestra carsica*; (Russian.) *karstovoe okno*; (Spanish.) *dolina en ventana*; (Turkish.) *karst penceresi*; (Yugoslavian.) *krsko (krasko) okno*.

karstic. Occasionally used as the adjective form of karst^[10] and pertaining to karst landforms or processes^[19].

karstification. 1. The processes of solution and infiltration by water, mainly chemical but also mechanical, whereby the surface features and subterranean drainage network of a karstland are developed to form a karst topography, including such surface features as dolines, karren, and mogotes and such subsurface features as caves and shafts. An area currently or formerly undergoing karstification, and thus characterized by karst landforms, is said to be karstified^[19]. 2. The process by which karst is formed. The term has been given a wide range of meaning, from almost a synonym for corrosion of soluble rocks by water to a term comprising all processes responsible for the development of karst features including, besides corrosion, such phenomena as mechanical erosion, jointing, and faulting^[20]. Synonyms: (French.) *karstification*; (German.) *Verkarstung*; (Greek.) *apokarstosis*; (Italian.) *carsificazione*; (Russian.) *karstoobrazovanie*; (Spanish.) *karstificación*; (Turkish.) *karstlaşma*; (Yugoslavian.) *okršavanje, zakrasevanje, karstifikacija*.

karstland. A region characterized by karst topography^[10].

Karstrandebene. (German.) See *karst margin plain*.

katavothron. (Greek.) A closed depression or swallow hole^[10].

Kegelkarst. (German.) A general term used to describe several types of tropical humid

karst characterized by numerous, closely spaced cone-, hemispherical-, or tower-shaped hills having intervening closed depressions and narrow steep-walled karst valleys or passageways^[10]. See also *cockpit karst*; *cone karst*; *Halbkugelkarst*; *tower karst*.

keld. See *rising*.

keyhole passage; keyhole. 1. This very descriptive name derives from the cross-sectional shape of a cave passage that consists of a phreatic tube with a vadose canyon cut in its floor. It is the classic example of a two-phase cave passage that originated and began its development in the phreas and was then modified by vadose entrenchment. As this sequence is the result of water table lowering by normal surface erosion, keyholes are common. Some keyholes are so small that the lower slot is impassable and the caver has to squeeze along the upper tube; others are very large. Spectacularly long is the 5 km of keyhole forming the Fissures in Castleguard Cave, Canada. A tube 6m in diameter tops an irregular tapering canyon 15 m deep that must be traversed on sloping ledges at mid-level^[9]. 2. A small passage or opening in a cave; in cross section, rounded at the top, constricted in the middle, and rectangular or flared out below^[10]. They appear as keyholes when viewed in cross section. They are formed when underground streams flowing in a tubular passage begin downcutting to form a canyon passage^[15]. See also *canyon passage*; *passage*; *tubular passage*; *vertical shaft*.

klinkenberg effect. The slip of gas molecules at the pore wall giving apparently higher

permeability than would be obtained by liquid measurements^[16].

Kluft. See *aisle*.

Kluftkarren. (German.) See *grike*.

knobstone. Speleothem, larger, more pronounced, and more widely separated than cave coral^[10].

knots. Various methods of securing or tying ropes or webbing material together by cavers^[13]. See also *prusik knot*; *prusiking*.

kras; krš. A slavic word meaning “bleak, waterless place,” from which the term “karst” is derived^[10]. See also *karst*.

Kugelkarst. See *Halbkugelkarst*.

kunker. See *caliche*.

L

laboratory coefficient of permeability, standard coefficient of permeability.

Permeability defined for controlled temperature conditions (60°F) as gallons per day per square foot (gpd/ft²) under a unit gradient^[16]. See also *Meinzer unit*.

labyrinth. See *network; maze cave*.

lacustrine formation. A sedimentary formation of lacustrine origin.

lag time. A time lapse between the onset of a given event and the produced results^[16].

lagoon. A body of relatively shallow water near a sea shore, with or without a direct connection to the sea^[16].

lake. 1. As used in speleology, a body of standing water too deep to walk across^[10].
2. A body of fresh inland water^[16].

laminar flow. Flow in which the head loss is proportional to the first power of the velocity^[22]. Water flowing in a laminar manner will have streamlines that remain distinct and the flow direction at every point remains unchanged with time. Synonymous with streamline flow, viscous flow.

lamination. The layering or very thin bedding of sedimentary rocks^[16].

landfill. A general term indicating a disposal site for refuse, dirt from excavations, junk^[6], and hazardous wastes.

land-form. A topographic feature of the earth's surface^[16].

land pan. An evaporation pan used to measure evaporation from a land surface; the pan is usually mounted at the land surface^[16].

landslide. The sliding down of earth and rock on a slope^[16].

land subsidence. The subsidence of a surface due to a loss of support^[16]. Often occurs as a result of overpumping underlying aquifers or as a result of mining activities. In karst terranes, subsidence can occur as a result of man-made changes to the natural hydrologic system (ground-water withdrawals or storm-water injection) or as a consequence of the natural dissolution process. Subsidence may be sudden or progress slowly over time.

land surface. That part of the lithosphere usually not covered by water^[16].

land-use. A particular utilization of a land surface especially with respect to its influence on the hydrologic cycle^[16].

lapiés. (French; sometimes spelled lapies or lapiaz.) Term for a region with outcrops of small regular pillars, cones, or blocks of carbonate rock^[20]. Synonyms: (French.) *lapies*; (German.) *Karren*; (Greek.) *lapiaz*, *lenar*; (Italian.) *lapia*, *solcato*, *carregiato*; (Russian.) *karri*; (Spanish.) *lenar*; (Turkish.) *erime oluğu*, *lapy*; (Yugoslavian.) *škrapa*, *grižine*, *bridine*, *žlebici*. See *karren*, *rock-rill*, *grikes*.

lateral moraine. A glacial deposit at the flank of a glacier, often constituted by debris from valley walls^[16].

laterite. A tropical ferruginous clay soil^[16].

lateritic soil. A red-colored soil with high iron oxide content^[16].

lava bed. A lava flow of considerable areal extent and relatively small thickness^[16].

lava cave, lava tube. 1. A cave that formed in a partly cooled, broadly basaltic or phonolitic lava, not by erosion but by molten material flowing away. In most cases, an initial active lava conduit is formed when a flowing surface lava stream has a roof grow over it by accretion of chilled solidified material. Insulated inside its conduit, the lava can continue to flow and develop an airspace above it, which is preserved as an explorable cave when completely cooled. Most lava caves are just very long tubes, though branching and multiple levels may occur as dictated by flow patterns and re-invasions of older tubes. On Kilauea Volcano, Hawaii, the Kazumura Cave is 47 km long and descends 888m, but its tubes, mostly 5m in diameter, lie less than 20 m beneath the sloping surface of the lava^[9]. 2. A cave in a lava flow, generally formed by gas blistering the surface or by lava flowing out from beneath a solidified crust, forming a tube or tunnel^[10]. 3. An empty tubular supply channel from which liquid lava has drained^[16]. See also *lava karst*; *pseudokarst*.

lava karst. A nonkarst term. Subsurface openings formed in lava flows due to outflow of liquid lava from beneath a solidified crust or due to gas blisters. Tubes or tunnels are formed with such pseudokarst features as lava stalactites and also collapse structures and basins of closed drainage. Lava karst does not arise through

solution of the rock by circulating water and thus is not a true karst^[20]. Synonyms: (French.) *pseudo-karst*; (German.) (*Vulkanischer Karst*), *Lava-Karst*, *Pseudokarst*; (Greek.) *pseudokarst*; (Italian.) *pseudocarsismo vulcanico*; (Spanish.) *volcanokarst* (general), *tubo volcanico* (tube, tunnel), *jameo* (collapse structure), *malpaís* (topographic feature similar to lapiés); (Turkish.) *lav karstı*, a *ldaticı karst*. See also *lava cave*; *pseudokarst*.

layer. A sheetlike deposit of sediment^[16]. Bed or stratum of rock^[16].

leachate. 1. Materials removed by the process of leaching^[22]. 2. A liquid that has percolated through soil rock or waste and has extracted dissolved or suspended materials^[22].

leaching. 1. The removal of materials in solution from soil, rock, or waste^[22]. 2. Separation or dissolving out of soluble constituents from a porous medium by percolation of water^[22].

leak. An opening in an aquiclude that permits penetration of water from other formations into the main aquifer^[16].

leakage. 1. The flow of water from one hydrogeologic unit to another. The leakage may be natural, as through semi-impervious confining layer, or manmade, as through an uncased well^[22]. 2. The natural loss of water from artificial structures as a result of hydrostatic pressure^[22].

leakage factor. The factor describing leakage flow into or out of a leaky aquifer^[16].

leakance. 1. The ratio K'/b' , in which K' and b' are the vertical hydraulic conductivity and the thickness, respectively, of the confining beds^[22]. 2. The rate of flow across a unit (horizontal) area of a semipervious layer into (or out of) an aquifer under one unit of head difference across this layer. Synonymous with *coefficient of leakage*^[22].

leaky aquifer. Aquifers, whether artesian or water-table, that lose or gain water through adjacent less permeable layers^[22].

lecontite. A cave mineral — $(\text{NH}_4, \text{K})\text{Na}(\text{SO}_4) \cdot 2\text{H}_2\text{O}$ ^[11].

leucophor. One of a family of optical brightening agents that have been used with some degree of success in water-tracing experiments. It has no color, but is readily detected by its distinctive fluorescence under ultraviolet light^[9].

levee. An artificial bank to prevent overbank flow of a river^[16].

level. 1. Within a cave, a group of passages developed in the same horizontal plane^[10]. 2. The altitudinal relation of a cave floor to an outside surface^[10]. 3. The surface of water in a well or standing reservoir^[16].

lift. The vertical pumping distance between the water level in a well to the land surface^[16].

light hole. (Jamaican.) 1. A hole in the roof of a cave through which light enters; sometimes a nonfunctioning swallow hole^[20]. 2. Fossil or abandoned swallow hole^[10].

lime. Calcium oxide, CaO ; used loosely and incorrectly in referring to limestone^[10].

lime sink. See *sinkhole*.

limestone. Sedimentary rock containing at least 50% calcium carbonate by weight. The purer limestones consist almost entirely of calcite; less pure rocks may be referred to as, for example, muddy limestone. Some limestones are porous with diffuse permeability; these rarely become truly cavernous, though some fissure flow may occur. Where ground-water flow in less porous rocks is restricted to bedding-related fissures and secondary fractures it can, even when moving very slowly, corrode the almost entirely soluble rock and lead to true cave development^[9].

limestone pavement. 1. A level, or gently inclined, bare limestone surface scored and fretted by karren. The stripping of soil or cover rocks to expose the bare rock pavement is a glacial process, and the development of the karren — both the dissolutional enlargement of the joints and also the dissolutional carving of runnels — is largely postglacial. Limestone pavements are characteristic features of glaciokarst and occur extensively in the north of England, in the Burren of County Clare in Ireland, and on many high alpine limestones^[9]. 2. A bare plane surface of limestone, parallel to the bedding, commonly divided into blocks (clints, Flachkarren) by solutionally widened joints (grikes, Kluffkarren), and pitted by solution pans^[10]. 3. A glaciokarstic landform, produced on a glacially planed limestone surface that has subsequently become dissected into blocks (clints or dalles) by solution enlargement of vertical joints^[19]. 3. Horizontal or sloping platforms

of bare limestone whose surface usually coincides with bedding-plane partings of the rock; often eroded into clint and grikes rock forms^[20]. Synonyms: (French.) *plateforme calcaire*; (German.) *Kalk Plattform*, *Limestone Pavement*; (Greek.) *karstikon lithostroton*; (Spanish.) *lapias entrecruzado*; (Turkish.) *kireçtaşı döşemesi*. See also *clints*; *grikes*; *Karrenfeld*.

limestone sink. See *sinkhole*.

limnology. The study of lakes^[16].

line of seepage. See *seepage line*.

lineation. The parallel orientation of structural features that are lines rather than planes. Some examples are parallel orientation of the long dimensions of minerals, long axes of pebbles, striae on slickensides, and cleavage-bedding plane intersections.

liquid. An incompressible or nearly incompressible fluid.

lithologic factor. The factor influencing composition, texture, and sequence of rock types^[16].

lithology. 1. The physical characteristic of a rock, including composition, grain size, texture, degree of cementation (or lithification) and structure, that determine the rock type^[9]. 2. The physical properties and aspect of a rock^[16].

lithosol. A rocky soil^[16].

lithosphere. That part of the earth's crust containing solid rocks^[16].

lithostratigraphy. A formal naming system that allows the description of rock successions in terms of recognizable defined units on a local scale. The units, which comprise supergroups, groups, formations, members, and beds in decreasing order of size, are described on the basis of observable characteristics^[9].

littoral zone. The coastal strip where rocks that are above sea level are in contact with rocks that are generally below sea level. Where suitable aquifer conditions occur across the littoral zone, notably around relatively young carbonate islands, fresh ground water interfaces with saline ground water at the halocline and dissolutional processes are enhanced by mixing water and, possibly, by microbial effects^[9].

live cave. Cave in which there is river action or active deposition of speleothems. Compare *active cave*^[10].

LNAPL. Abbreviation for light nonaqueous phase liquid. Liquids falling into this category have specific gravities that are less than water (the specific gravity for water is usually taken to be 1), are relatively immiscible with water, and tend to migrate downwards through the vadose and to float on top of the water table. See also *LNAPL*; *immiscible*; *NAPL*.

loam. Calcareous clay^[16].

localized circulation. Circulation in karst aquifers in which the water moves in certain preferred zones and does not occupy all or most of the openings below this level^[10]. Synonyms: (French.) *circulation préférentielle*; (German.) *Örtlich begrenzte Karstwasser-Zirkulation*; (Italian.)

circolazione carsica parziale; (Spanish.) *circulación localizada*; (Turkish.) *yersel dolaşım*; (Yugoslavian.) *lokalizirana (lokalna) cirkulacija*. Compare *diffuse circulation*.

lodgement till. Glacial till deposited from slowly melting ice at the base of a glacier^[16].

loess. Fine-grained and poorly consolidated windblown sediment, mainly of silt. Great thicknesses of loess are found in areas marginal to hot and cold deserts, where the prevailing wind deposits fine dust particles blown from the desert basins or out of glaciofluvial sediments. Loess is a common allogenic component of soils on limestones. Large numbers of artificial caves have been excavated in the hillsides of soft loess in central China^[9].

longitudinal fault. A fault having the same direction of strike as the surrounding strata^[16].

loosest packing. The three-dimensional arrangement of particles with the highest possible void volume per unit cell^[16].

losing stream. A stream or reach of a stream in which water flows from the stream bed into the ground^[22]. In karst terranes, losing streams may slowly sink into fractures or completely disappear down a ponor. Synonym: *influent stream*. See also *ponor*; *stream sink*.

lost circulation. The result of drilling fluid escaping from a borehole into the formation by way of crevices within the formation^[6]. It is a common occurrence in most karst aquifers because of the existence of large

subsurface voids that are sometimes intersected during a drilling program.

lost river. 1. A surface river or stream flowing onto or over karst that then disappears completely underground through a swallow hole (ponor) and which may or may not rise again and flow as a resurgent surface river or stream^[20]. 2. In a karst region, a surface stream that enters an underground course^[10]. Synonyms: (French.) *perte de rivière*; (German.) *Flußversickerung, Flußchwinde*; (Greek.) *chanomenos potamos*; (Russian.) *iscezajuscaja reka*; (Spanish.) *rio sumente*; (Turkish.) *kayıp nehir*; (Yugoslavian.) *ponornica, ponikalnica*. See also *ponornica*; *sinking stream*. Compare *intermittent river*.

lower confining bed. An impermeable bed underlying an aquifer^[16].

lower course. The part of a water course near a discharge point^[16].

low flow. The lowest sustaining flow during base runoff conditions of a river^[16].

Lycopodium spores. 1. The spores of a club moss, with individual structures about 0.03 mm in diameter. Easily transported by and almost indestructible in cave water, the spores can be dyed a variety of colors, and offer a valuable water-tracing technique. Preparation and collection of the spores is very tedious, and the method lacks the convenience of using simple dyes^[9]. 2. Spores of *Lycopodium clavatum*, which can be used in natural or dyed color as a label in studying ground-water movement in karst areas^[10].

lysimeter. A device for measuring percolation and leaching losses from a column of soil under controlled conditions^[22].

M

Ma. Internationally accepted abbreviation for million years, commonly applied to measurements of geological time. This abbreviation is currently used in preference to My^[9].

macrokarst. Karst area with large morphological features. The term is not easily defined because it lacks limits^[20]. Synonym; (Italian.) *merocarsismo*. Compare *microkarst*.

macropore. A pore with dimensions such that capillary forces become less important during flow^[16].

magnesian limestone. Common but loose synonym for dolomitic limestone or dolomite rock. The magnesian limestone of northern England is a rock sequence of Permian age that includes a locally variable number of beds of dolomitic limestone^[9].

magnesite. A cave mineral — $MgCO_3$ ^[11].

malachite. A cave mineral — $Cu_2(CO_3)(OH)_2$ ^[11].

manatial. (Spanish.) Spring. See also *spring*.

Manning equation. An equation used to compute the velocity of uniform flow in open channel: $V=1.486/n R^{2/3} S^{1/2}$, where V is the mean velocity of flow (in cfs units), R is the hydraulic radius in feet, S is the slope of the channel or sine of the slope angle, and n is the Manning roughness coefficient^[1]. See also *Chézy equation*; *Froude number*; *Reynolds number*.

manometer. A pressure measuring device for determining the hydraulic head developed by a flowing fluid^[16].

mantled karst. Karst topography that is wholly or partly covered by a relatively thin veneer of post-karst rock or sediment and is part of the contemporary landscape^[17]. See also *buried karst*; *covered karst*.

marble. 1. Metamorphosed and recrystallized carbonate rock that is generally capable of supporting cave development. For example, much of the Antro del Corchia in Italy and many caves in the South Nordland area of Norway have formed in marble^[9]. 2. Limestone recrystallized and hardened by heat and pressure. 3. Commercially, any limestone that will take a high polish^[10].

marginal polje. 1. Flat plain surrounded by higher limestone country on all except one side, which consists of impermeable ridges or hills. Such a feature is normally found on the edge of a karst area or region^[20]. 2. Flat limestone plain that is surrounded by higher country but is bordered on one side by impervious rock^[10]. Synonyms: (French.) *polje marginal*; (German.) *Randpolje*, *Semipolje*; (Greek.) *perithoriakón 'polje'*; (Italian.) *polje marginale*; (Spanish.) *polje marginal*; (Turkish.) *kenar gölova*; (Yugoslavian.) *rubno polje*, *robno polje*. See *Randpolje*. Compare *blind valley*.

marine water. Ocean water having invaded coastal aquifers^[16].

marker bed. A bed with characteristic features that can be followed over large areas for identification purposes^[16].

marl. Unconsolidated sedimentary rock consisting largely of calcium carbonate and clay; usage varies from calcareous clay to earthy limestone, and in some parts of the United States, the term has been used for any unconsolidated sedimentary rock containing fossil shells^[10].

mass curve. A graph of cumulative values of a hydrological quantity against time^[16].

mass density. Mass per unit volume of a substance^[16].

mass flowmeter. A measuring device for mass flow rates^[16].

massive structure. A homogenous structure without any oriented features^[16].

master cave. Best defined as a low-level trunk streamway cave with many tributaries. The old concept of the master cave being formed at the water table should be disregarded. The Leck Fell Master Cave, in the Yorkshire Dales, is 2 km long, partly a vadose canyon, partly a drained phreatic tube, and partly a submerged tube. Part of it therefore lies below the water table while elsewhere its presence controls the water table. The French equivalent, “collecteur,” is more descriptive of the master cave’s true role. The depth to a currently active master cave is dictated by interactions among local topography, stratigraphical factors, and geological structure. In the low hill karst of England and Kentucky, active master caves lie at depths of around 100 m, but in Monte Canin, Italy, and the Hautla Plateau, Mexico, they lie at depths of 1000 m. The collecteur of the Gouffre Berger, France, is met just 250 m down but can be followed

to a depth of over 1000 m, down the dipping limestone beds, thus emphasizing the local dominance of stratigraphical over topographical factors^[9].

match point. A common point in the superposition of a type curve over measured data in aquifer test analyses.

matric potential. The energy required to extract water from a porous medium to overcome the capillary and adsorptive forces^[22].

matrix. The solid framework of a porous system^[22].

maximum basin relief. The elevation difference between basin mouth and highest point within a basin perimeter^[16].

maze cave. A cave with an essentially horizontal network of interconnecting and mainly contemporaneous passage loops. Three broad types of maze cave have been described — anastomotic, network, and spongework — and these may be subdivided on the basis of how they developed: by slow-moving water, restricted to a confined artesian aquifer, or by water that is ponded from backflooding. A mechanism of potentially great importance, particularly in the context of the inception of network maze caves, is multiple, diffuse input from adjacent, permeable but noncavernous rocks. Spectacular joint-guided maze caves such as Knock Fell Caverns and the Devis Hole Mine Caverns occur in the thin Yoredale limestones of the northern Pennines, but the most extensive mazes are in the Black Hills of Dakota, USA (including Jewel Cave) and in the Ukrainian gypsum karst (including

Optimisticeskaja)^[9]. See also *maze cave pattern*.

maze cave pattern. A cave system that consists of a labyrinth of intersecting passages of rather uniform character that form closed loops. See also *anastomotic cave pattern*; *maze cave*; *network cave pattern*; *spongework cave pattern*.

mean deviation. A linear mean of absolute deviations^[16].

mean value. The statistical average or measure of central tendency^[16].

meander. 1. Overdeveloped and self-exaggerated bend in a stream course either on the surface or underground, caused by more erosion on the outside than on the inside of a bend through natural wash of the flow. Underground meanders commonly originate within bedding-plane-guided elements of the phreas, where a single dominant tube has gathered drainage from the surrounding area. Following uplift and the onset of vadose conditions, any stream that utilizes the meandering tube incises rapidly and the imposed meander course is entrenched into the underlying rocks. Such incision or entrenchment produces characteristic tall, narrow, twisting vadose canyons, to such an extent that the French describe them as “meandres.” Canyons may meander more at their lower levels because of enlargement during incision^[9]. 2. A loop-like bend in a river due to lateral erosion activities^[16]. 3. In a cave, an arcuate curve in a channel formed by lateral shifting of a cave stream^[10]. See *ceiling meander*; *meander niche*.

meander belt. A zone within which meandering of a stream occurs^[16].

meandering karren. These are small grooves cut directly into the rock surface, generally a few centimeters wide and deep. Their size remains the same or decreases downslope and they usually exhibit small meanders with typical undercut slopes and slip-off slopes. They frequently appear in the bottom of larger grooves such as *rinnenkarren*^[3]. See also *wall karren*; *humus-water grooves*. Synonym: (German.) *Müanderkarren*.

meander niche. A conical or crescent-shaped opening in the wall of a cave, formed by the downward and lateral erosion of a stream on the floor of a passage^[10].

measuring flume. An artificial channel used for discharge measurements.

measuring weir. A device used to measure flow rates indirectly through a weir head.

mechanical ascender. A mechanical device that is the same as an ascender, but is used to clarify the use of a mechanical device instead of a rope ascender knot^[13]. See also *ascender*.

mechanical cover. A mechanical covering of a free water surface to prevent evaporation.

mechanical dispersion. The process whereby solutes are mechanically mixed during advective transport caused by the velocity variations at the microscopic level. Synonymous with *hydraulic dispersion*^[22].

mechanical dispersion, coefficient. The component of mass transport flux of solutes

caused by velocity variations at the microscopic level. Synonymous with *convective diffusion*^[22].

median. A value dividing frequency of varieties into two equal portions^[16].

medicinal spring. See *spring, medicinal*.

medium sand. Grain particle with a diameter of 0.25 to 0.5 mm^[16].

Meinzer unit. A measure of hydraulic conductivity as gpd/ft² under a unit hydraulic gradient^[16].

melanterite. A cave mineral — FeSO₄·7H₂O^[11].

melting. The passage from the solid to the liquid state due to temperature increases^[16].

melting point. The temperature at which a solid substance is transformed into its liquid state^[16].

meltwater. Water derived from the melting of snow pack or of a glacier^[16].

meniscus. A free surface or interface formed by liquid in a capillary tube^[16].

mercury column. A cylindrical bore in a manometer filled with mercury^[16].

mercury injection method. A measurement of porosity by mercury injection into a sample^[16].

merokarst. 1. Defined by Cvijić to indicate imperfect karst topography as found on thin, impure, or chalky limestone where surface drainage and dry valleys are present

in addition to some karstic features^[10]. 2. Karst developed in soluble rocks retaining considerable surface drainage. Synonyms: (French.) *merokarst*; (Turkish.) *yarı karst*. Contrast perfectly formed Holokarst. Compare *causse*.

mesh. 1. An opening in a sieve screen^[16]. 2. Number of openings per inch^[16].

mesophyte. A plant growing under intermediate moisture conditions^[16].

meteoric water. Water recently involved in atmospheric circulation^[16].

meteorology. The science dealing with all physical phenomena occurring in the atmosphere^[16].

Mexican onyx. See *onyx marble*.

micrite. A microscopic texture. An abbreviation of “microcrystalline calcite ooze,” which refers to precipitated finely crystalline carbonate sediments in grains from 1 to 4 microns in diameter^[20]. Synonyms: (French.) *micrite*; (Greek.) *micrite*; (Italian.) *micrite*; (Spanish.) *micrita*; (Turkish.) *mikrit*; (Yugoslavian.) *mikrit*. See *biomicrite*, *peloid*.

microkarren. Very small dissolutional channels, commonly 1-3 mm across; parallel, convergent, or randomly intersecting on a limestone surface. Though found in all climatic regions, they are most conspicuous in semiarid and periglacial environments, where dissolutional processes are minimal and very slow. The random patterns of some microkarren may be due to the effects of condensation water^[9].

microkarst. 1. Karst area with small morphological features. This term is not easily applied because it lacks limits^[20]. 2. Karst topography in which all surficial features are small; an area dominated by minor karst features^[10]. Compare *macrokarst*.

microspar. A microscopic texture. Mosaic of tiny (4 to 10 micron diameters) clear calcite crystal^[20]. Synonyms: (French.) *microsparite*; (Greek.) *mikrosparitis* (*mikroskopikón*, *mosaikón kristállon*); (Italian.) *microsparite*; (Spanish.) *microesparita*; (Turkish.) *mikrospar*.

middens. Accumulations of animal droppings other than guano and often found in caves; may be solidified^[13]. See also *cave guano*; *guano cave*; *coprolite*.

migration. The movement of water, contaminants, or other fluids in the geologic substratum, mostly by natural causes^[16].

mine drainage. Waters coming from or passing through surface or subsurface mine workings^[16].

mine water. Water accumulating in a mine.

minerals. Mineral components of a rock, often in macrocrystalline form^[16].

mineral spring. See *spring, mineral*.

mining of ground water. The permanent depletion of ground-water reserves^[16].

minor karst features. See *karren*; *rill*; *solution pan*.

mirabilite. The natural white mineral form of hydrated sodium sulfate, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ^[9], which may grow as cave flowers or in various other forms similar to those of gypsum.

Mischungskorrosion. (German.) Dissolution of calcite (and hence of limestone) by ground water that is derived from the mixing of two different waters that were originally saturated with carbon dioxide but had reached saturation under differing carbon dioxide partial pressures. The resultant mixture is undersaturated and capable of further calcite dissolution, because the relationship between calcite solubility and carbon dioxide partial pressure is nonlinear^[9].

miscible. 1. Two or more liquids that are mutually soluble (i.e., they will dissolve in each other)^[22]. 2. The chemical property of two or more phases that, when brought together, have the ability to mix and form one phase^[22].

miscible displacement. 1. The mutual mixing and movement of two fluids that are soluble in each other^[22]. 2. The displacement of a fluid saturating a porous medium by another fluid completely miscible with the first fluid^[16]. Synonymous with miscible-phase displacement.

mixing length. The length over which mixing occurs, especially of momentum in turbulent flow^[16].

mixture corrosion. See *Mischungskorrosion*.

mode. The most frequently occurring variate in a frequency distribution^[16].

model. 1. A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous in some way^[22]. 2. A conceptual description and the associated mathematical representation of a system, subsystem, components, or condition that is used to predict changes from a baseline state as a function of internal and/or external stimuli and as a function of time and space^[22]. 3. A simplified system bearing some physical similarity to a prototype^[16].

model technique. A method of solving complex physical problems through the application of simplified models^[16].

mogote. A steep-sided hill of limestone, generally surrounded by nearly flat alluviated plains: karst inselberg. Originally used in Cuba in referring to residual hills of folded limestone in the Sierra de los Organos but now used internationally for karst residual hills in the tropics^[10]. Differs from cone, cupola, pinnacle, and tower karst in its shape which reflects its karstification history^[20]. Synonyms: (French.) *mogote*; (German.) (*Karstinselberg*), *Mogote*; (Greek.) “*moghotis*” (*apókrimnos, asvestólofos perikliómenos apó proschomatikas pediadas*); (Italian.) *mogote, rilievo carsico residuo*; (Spanish.) *mogote*; (Turkish.) *karst kalıntı tepesi*; (Yugoslavian.) *hum*. See also *hum*; *karst inselberg*; *pepino hill*.

moisture content. 1. The ratio, expressed as a percentage, of either (a) the weight of water to the weight of solid particles expressed as moisture weight percentage or (b) the volume of water to the volume of

solid particles expressed as moisture volume percentage in a given volume of porous medium^[22]. 2. The gravimetric water vapor content of air^[16]. See also *water content*.

moisture deficiency. The quantity of water required to restore moisture to field capacity in a desiccated soil^[16].

moisture equivalent. The percentage of water retained in a soil sample 1 cm thick after it has been saturated and subjected to a centrifugal force 1000 times gravity for 30 min. Centrifuge moisture equivalent is the water content of a soil after it has been saturated with water and then subjected for 1 hour to a force equal to 1000 times that of gravity^[22].

moisture tension. The equivalent negative pressure of water in an unsaturated porous medium equal to the pressure that must be applied to the medium to bring the water to hydraulic equilibrium through a porous permeable material with a pool of water of the same composition. Synonym: *capillary tension*^[22].

moisture volume percentage. The ratio of the volume of water in a soil to the total bulk volume of the soil^[22].

moisture weight percentage. The moisture content expressed as a percentage of the oven-dry weight of a soil^[22].

molecular diffusion (diffusion.) The process whereby solutes are transported at the microscopic level because of variations in the solute concentrations within the fluid phases^[22]. The kinetic energy generated by the transport of ionic or molecular

constituents results in some dispersion of a chemical.

molecular diffusion, coefficient of. The component of mass transport flux of solutes (at the microscopic level) due to variations in solute concentrations within the fluid phases. Synonymous with *diffusion coefficient*^[22].

molecule. A stable configuration of atomic nuclei and electrons bound together by electrostatic and electromagnetic forces. It is the simplest structural unit that displays the characteristic physical and chemical properties of a compound^[6].

mollisol. A soil layer subject to annual thawing and freezing, often becoming mobile upon thawing^[16].

monetite. A cave mineral — CaHPO_4 ^[11].

monohydrocalcite. A cave mineral — $\text{CaCO}_3 \cdot \text{H}_2\text{O}$ ^[11].

monomolecular film. A layer of monomolecular thickness of a polar substance spread over a free water surface to prevent evaporation.

montgomeryite. A cave mineral — $\text{Ca}_4\text{MgAl}_4(\text{PO}_4)_6(\text{OH})_4 \cdot 12\text{H}_2\text{O}$ ^[11].

montmorillonite. A clay mineral containing magnesium oxide (MgO) in its structure^[16].

moonmilk. 1. A white plastic calcareous cave deposit composed of calcite, huntite, or magnesite. From Swiss dialect “moon-milch,” elf’s milk. Corrupt spelling “mondmilch” is common^[10]. 2. Deposits consisting mainly of very fine particles of

calcium and magnesium carbonate precipitated from water in caves and caverns. When in suspension, they give the water the appearance of milk. Name originated in 1714 by M. B. Valentini (Fénelon)^[20]. 3. Moonmilk consists of a variety of hydrocarbonates, some of which are associated with particular species of bacteria. A common mineral in moonmilk from temperate caves is hydromagnesite; cold caves yield moonmilk of calcite after hydrocalcite^[20]. Synonyms: (French.) *mondmilch*; (German.) *Bergmilch*, *Montmilch*; (Greek.) *speleogala*; (Italian.) *latte di monte*; (Russian.) *kamennce moloko*; (Spanish.) *mondmilch*, *leche de luna*; (Turkish.) *dik karstik kalıntı*; (Yugoslavian.) *gorsko mlijeko (mleko)*. Also mountain milk.

moor. A wet peat bog^[16].

moulin. The French word for “mill,” moulin has been used to describe partially dissolutional, partially scoured pockets cut in rock, particularly the potholes formed in the beds of surface and underground streams. In some areas sinkholes in the surface of glaciers, which may provide access to glacier caves, are also referred to as moulins^[9].

mountain milk. See *moonmilk*.

moraine. A mound, ridge, or other distinct accumulation of unsorted, unstratified glacial drift, predominantly till, deposited chiefly by direct action of glacier ice^[6].

morphometric analysis. A geodetic and geometric description of basin and stream network or to a sinkhole plain^[16].

mud. Water-saturated fine clayey earth material^[16].

mud crack. Desiccation cracks appearing in drying mud surfaces due to shrinkage^[16].

mud stalagmite. 1. Stalagmitic column made of mud or clay with about 30% calcium carbonate cement. There may be some coarse noncalcareous detritus in the core of such a column^[20]. 2. Stalagmite composed principally of clay or sandy clay and commonly less than 30% calcium carbonate^[10]. Synonyms: (French.) *stalagmite d'argile*; (German.) *Stalagmit aus Tonschlamm*; (Greek.) *pilostagmitis*; (Italian.) *stalagmite di fango*; (Spanish.) *ostalagmita de barro*; (Turkish.) *çamur dikiti*. Related to *stalagmite*.

mudflow. A flow of water-saturated unconsolidated debris^[16].

multiaquifer formation. A formation with several aquifers overlying each other^[16].

multiaquifer well. A well completed and tapping several aquifers^[16].

My. See *Ma*.

N

Nackter karst. (German.) See *exposed karst*.

Nacktkarst. (German.) See *exposed karst*.

naked karst, bare karst. Karst topography developed beneath a temporary cover. Some naked karsts develop beneath a temporary cover of snow (nival karst) or water^[17]. Synonyms: (French.) *karst nu*; (German.) *oberflächlicher nackter Karst*; (Greek.) *gymnon karst*; (Italian.) *carso nudo*; (Russian.) *golyĭ karst* or *otkrytyĭ karst*; (Spanish.) *karst desnudo*; (Turkish.) *çıplak karst*; (Yugoslavian.) *goli krš*. See also *exposed karst*.

NAPL. Abbreviation for nonaqueous phase liquid. This term is used to describe the physicochemical relationship that exists between a bulk hydrocarbon and water which results in the two liquids being immiscible with one another (i.e., little or no mixing of the two liquids occurs.) The interface is a physical dividing surface between the bulk phases of the two liquids. NAPLs are divided into two categories; LNAPLs and DNAPLs. See also *DNAPL*; *immiscible*; *LNAPL*.

nari. Term used in the countries bordering the Eastern Mediterranean for caliche or hardpan^[20]. See *caliche*, *sabath*.

narrow. A passage of restricted width between two caves or hollows in the karst underground; often not readily traversable^[20]. Synonyms: (French.) *étroiture*; (German.) *Enge*; (Greek.) *steno perasma*; (Italian.) *strettoia*; (Russian.) *laz*; (Spanish.) *laminador*, *gatera*; (Turkish.)

ağiz geçit; (Yugoslavian.) *sutjeska*, *klisura*, *soteska*.

native ground water. Original ground water^[16].

natural arch. 1. A residual portion of the roof of a subsurface karst cavity that has not collapsed. Such a natural arch may occur as a surface topographic feature, or as a part of a cave system^[20]. 2. A rock arch or very short natural tunnel; contrasted with a natural bridge, which spans a ravine or valley^[10]. Synonyms: (French.) *arche naturelle*; (German.) *natürlisches Gewölbe*, *Naturbrücke*, *Felsfenster*, *Felsbrücke*; (Greek.) *physike apsitha*; (Italian.) *arco naturale*; (Russian.) *estestvennij arka*; (Spanish.) *arco natural*; (Turkish.) *doğal kemer*; (Yugoslavian.) *prirodni svod*, *luk*, *naravni obok*. See also *natural bridge*.

natural bridge. 1. A residual portion of the roof of a subterranean stream that has not collapsed and is found bridging a valley. Normally a surface feature, but may be used to describe a similar occurrence in a cave system^[20]. 2. A rock bridge spanning a ravine and not yet eroded away^[10]. Synonyms: (French.) *pont naturel*; (German.) *Naturbrücke*, *Felsbrücke*; (Greek.) *physiki gefyra*; (Italian.) *ponte naturale*; (Russian.) *estestvennij most*; (Spanish.) *puente natural*; (Turkish.) *doğal köprü*; (Yugoslavian.) *prirodni most*, *naravni most*. See also *natural arch*.

natural levee. A river bank raised by the river's own depositions^[16].

natural load. Sediment carried by a stable stream^[16].

natural tunnel. A nearly horizontal cave open at both ends, generally fairly straight in direction and fairly uniform in cross section^[10].

natural water. Water with a mineral content occurring under natural conditions.

natural well. (Jamaican.) A vertical shaft in limestone, open to the surface and having water at the bottom; similar to a cenote^[10].
Synonym: (Italian.) *pozzo carsico*.

neck. A volcanic pipe filled with lava^[16].

neomorphism. A microscopic texture. A complex of processes whereby a mosaic of finely crystalline carbonate is replaced by a coarser (sparry) mosaic without the development of visible porosity. Dominant reactions are the wet transformation of aragonite to calcite and recrystallization. The process is “porphyroid” where some of the neomorphic crystals are conspicuously larger than those that surround them^[20].
Synonyms: (French.) *néomorphisme*; (German.) *Neomorphismus*; (Greek.) *neomorphismós*; (Spanish.) *neomorfismo*; (Turkish.) *neomorfizm*.

neptunian deposits. Younger sediment or sedimentary rock that infills preexisting cavities, such as grikes, dolines, or cave passages, in older rocks. The most common form is a fissure fill, known as a neptunian dike. Neptunian deposits occupy voids in nonkarstic as well as karstic rocks, and the combination of void and fill may subsequently be buried by still younger rocks. They may thus become part of a paleokarst^[9].

nesquehonite. A cave mineral — $\text{Mg}(\text{HCO}_3)(\text{OH})\cdot 2\text{H}_2\text{O}$ ^[11].

nested sinkholes. (American.) See *uvala*.

net radiation. The sum of incident and reflected sun and sky shortwave radiation plus incident and reflected atmospheric long-wave radiation^[16].

network cave pattern. A type of maze cave characterized by a complex pattern of repeatedly connected passages in a cave system. In map view, this type of maze cave appears similar to a city street map. It is typically formed by solutionally aggressive water infiltrating through fractures in an overlying insoluble cap-rock thus exhibiting a joint-controlled pattern.
Synonym: *labyrinth*.

neutrality point. The separation point between acid and basic solution with a pH of 7.0^[16].

nip. An undercutting notch in rock, particularly limestone, along a seacoast between high and low tide levels along sea coasts and produced by solution and erosion. Most common along coasts with limited tidal variation^[20].
Synonyms: (French.) *resserrement*, *étrangement*; (German.) *Kliff*, *Brandungsmarke*; (Greek.) *káto engopí vráchou*; (Italian.) *solco di battigia*; (Spanish.) *socavación marina*; (Turkish.) *dalga yarığı çentiği*.

nīsa. See *aisle*.

niter. A white orthorhombic mineral — KNO_3 . It is a soluble crystalline salt that occurs as a product of nitrification in most arable soils in hot, dry regions, and in the

loose earth forming the floors of some natural caves^[1]. Synonyms: *saltpeter*; *potassium nitrate*.

nitrammite. A cave mineral — NH_4NO_3 ^[11].

nitrocalcite. A cave mineral — $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ ^[11].

nitromagnesite. A cave mineral — $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ^[11].

nival karst. Alpine karst^[1].

nivo-karst. A karstlike topography produced by the differential chemical weathering beneath snowbanks from snowmelt containing carbonic acid. It is found mostly in periglacial areas^[1].

node point. The intersection point on a grid^[16].

nodule. A small, irregularly rounded knot, mass, or lump of a mineral or mineral aggregate, normally having a warty or knobby surface and no internal structure, and usually exhibiting a contrasting composition from the enclosing sediment or rock matrix in which it is embedded (e.g., a chert nodule in limestone). Most nodules appear to be secondary structures in sedimentary rocks; they are primarily the result of postdepositional replacement of the rock and are commonly elongated parallel to the bedding. Nodules can be separated as discrete masses from the host material^[1].

nominal. Used to describe standard sizes for pipe from $\frac{1}{8}$ inch to 12 inches (3.2 mm to 304 mm.) The nominal size is specified on the basis of the inside diameter. Depending

on the wall thickness, the inside diameter may be less than or greater than the number indicated^[6].

nongraded. An engineering term pertaining to a soil or an unconsolidated sediment consisting of particles of essentially the same size^[6].

nonpoint source. 1. Any source, other than a point source, that discharges pollutants into air or water^[22]. 2. Source originating over broad areas, such as areas of fertilizer and pesticide application and leaking sewer systems, rather than from discrete points^[22].

nonrecording gage. A standard rain gage (8 is standard in U.S.)^[16].

normal depth. The depth at which uniform flow occurs in an open channel^[16].

normal fault. A fault in which the upper block appears to have moved downward relative to the lower block.

noethphreatic flow. A type of conduit flow that is always laminar^[9].

O

oasis. A limited area in a desert supplied with water^[16].

obruk. Turkish form for a vertical or steep-sided depression or shaft in karst, often formed by collapse of the roof of an underground cave or cavern. When the depression contains a lake or pond, it is known as “sulu obruk” or “obruk gölü.” When it is dry, it is called “kuru obruk” or just “obruk.” Synonyms: (French.) *obruk*; (German.) *Schlot*; (Greek.) *obruk* (*káthetos karstikós lákkos*); (Italian.) *pozzo carsico*; (Spanish.) *torca*; (Turkish.) *obruk*; (Yugoslavian.) *jama*. See *cenote*, *dolina*, *jama*, *pit*, *shaft*, *sinkhole*.

obsequent river. A river flowing in a direction opposite to that of the dip of the underlying strata^[16].

observation well. A well drilled for the purpose of observations such as water level or pressure recordings^[16].

oceanic water. Sea water with a total salt content of about 34,500 ppm^[16].

ojo, ojo de agua. (Spanish.) An artesian spring in limestone regions, especially one forming a small pond; a vauculian spring^[10].

olivenite. A cave mineral — $\text{Cu}_2(\text{AsO}_4)(\text{OH})$ ^[11].

onyx marble. Translucent layers of calcium carbonate from cave deposits, often called Mexican onyx or cave onyx; used as an ornamental stone^[10].

oolite. A type of limestone that is composed largely or partly of ooliths. Also known as oolitic limestone. The best known examples in Britain, within the Jurassic limestone sequence of the Cotswolds, are of only moderate strength, very porous, and only weakly cavernous. In contrast, ooliths of early Carboniferous age have hosted extensive cave development beneath Mymydd Llangattwg and in other parts of South Wales^[9].

oolith. A small ovoid to spherical accretionary particle, usually composed of concentric layers of calcium carbonate. Such ooliths, cemented together by calcium carbonate, iron salts or other minerals, are the major constituent of oolite or oolitic limestone^[9].

oolitic. Of spherical or ovoidal shape^[16].

opal. A cave mineral — $\text{SiO}_2 \cdot n\text{H}_2\text{O}$ ^[11].

open system. A system where matter and energy may cross a system boundary^[16].

Opferkessel. See *solution pan*.

optical brighteners. Material contained in laundry detergents to make “whites whiter” and used in environmental tracing studies. Common types are Tinopal CBS-X, Tinopal 5BM GX, and Phorwite BBH Pure. Dye type: *Stilbene*. See also *fluorescent dyes*.

ore karst. Formation of interstices, caverns, caves, and other karst forms produced by solution in water from thermal springs and ore-bearing solutions^[20]. Synonyms: (French.) *karst minier*; (German.) *Zwischenräume*, *Kavernen*, *Höhlen im Karst*, *gebildet durch Thermalwässer oder*

erzhaltige Lösungen; (Greek.) *thermometallikon karst*; (Italian.) *carsismo per dissoluzione idrotermale*; (Russian.) *rudnij karst*; (Spanish.) *karst termomineral*; (Turkish.) *cevher karstı*; (Yugoslavian.) *rudni krš (kras)*.

organic deposit. Deposits of calcareous and siliceous remains of animals^[16].

organic pollution. Contamination originating from organic sources^[16].

orientation. 1. The assignment or imposition of a definite direction in space; the act of establishing the correct relationship in direction, usually with reference to the points of the compass. Also, the condition of being in such relationship. 2. In describing crystal form and symmetry, the placing of the crystal so that its crystallographic axes are in the conventional position. 3. The direction in which an aerial photograph is turned with respect to observer or map. A single photo is best oriented for study when turned so that the shadows are cast toward the observer. 4. Directional arrangement of nonspherical grains in a sand aggregate^[16].

original dip. Dip due to deposition of sediments^[16].

original interstice. Interstice formed during rock formation stage^[16].

orographic precipitation. Precipitation due to mechanical lifting of air over a ground relief^[16].

orthogonal. Perpendicular.

otkryĭ karst. (Russian.) See *naked karst*.

oulopholite. See *cave flower*.

outcrop. An open exposure of bedrock or otherwise buried material^[16].

outflow cave. Cave from which stream flows out or formerly did so^[10]. Synonym: *effluent cave*.

outlet cave. A cave developed at the point of re-emergence of an underground karst watercourse^[19].

output point. A point where water exists from an underground drainage route or aquifer. An obvious output point is a surface resurgence or exurgence, where drainage emerges from a conduit system. Less obvious are points where drainage leaves a carbonate aquifer and enters an adjacent non-carbonate bed, such as a sandstone aquifer^[9].

outwash. Stratified sand and gravel removed or washed out from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of an active glacier. The coarser material is deposited nearer to the ice^[6].

outwash gravel. Glacial drift material deposited by streams from a glacier^[16].

outwash plain. Plain in front of a glacier that is composed of outwash material^[16]. A broad, gently sloping sheet of outwash^[6].

ouvala. (French.) See *uvala*.

oven-dry. The degree of dryness of a porous sample after drying in an oven at a specified temperature^[16].

overbank area. An area covered by flood waters overtopping natural or artificial river banks^[16].

overburden. 1. The loose soil, sand, silt, or clay that overlies bedrock. In some usages it refers to all material overlying the point of interest. 2. The total cover of soil and rock overlying an underground excavation.

overburden pressure. The pressure exerted by weight of the overburden column^[16].

overflow spring. See *spring, overflow*.

overland flow. Surface runoff flowing over the land surface towards a channel^[16].

overthrust. Upthrust fault with a very low angle of dip and a relatively large net displacement^[16].

oxbow. Abandoned loop of a stream course, Original usage, applied to surface rivers, describes short-circuited meander loops, but in caves the term is applied to dry loop passages of any shape and origin^[9].

oxidation. The combining of an element with oxygen^[6].

oxygen demand. The ability of substances to utilize dissolved oxygen in water.

P

packing. The three-dimensional arrangement of particles^[16].

pahoehoe. (Hawaiian.) Lava flows with a smooth or billowy surface in which lava tubes are found^[13]. See also *lava cave*; *pseudokarst*.

paleokarst. 1. A karstified rock or area that has been buried by later sediments; in some places, ancient caves have been completely filled by the later sediments^[10]. 2. A decoupled contemporary system that has experienced tectonic subsidence and lie unconformably beneath clastic cover rocks, occasionally becoming exhumed and re-integrated into the active system^[17]. 3. A karst formed in the past under an earlier erosion cycle and often in remote geological times. The karst is preserved by burial or suspension of karstification processes^[20]. 4. A karstified surface and the karst features associated with it, such as caves, that have been buried by younger rocks. Paleokarstic features at various scales may be recognized within most carbonate successions. More rarely they may be re-exposed (exhumed) by the effects of later uplift and erosion^[9]. Synonyms: (French.) *paléokarst*; (German.) *Paläokarst*, *fossiler Karst*; (Greek.) *paleokarst*; (Italian.) *paleocarsismo*, *carsismo fossile*; (Russian.) *paleokarst*; (Spanish.) *paleokarst*; (Turkish.) *eski karst*; (Yugoslavian.) *paleokrš*, *paleokras*, *paleokarst*. See also *buried karst*.

paleokarstic surface. A surface, preserved within a carbonate succession, that was formed by the effects of karst erosion. The presence of a paleokarstic surface indicates

that during the deposition of the full rock sequence the young rocks were exposed to the effects of surface (sub-aerial) erosion. During such a nondepositional and erosional phase a full suite of karst features, including caves, could develop^[9].

paleomagnetism. Natural remanent magnetization preserved in rock sequences. During rock deposition magnetic minerals are aligned according to the direction and polarity of the earth's contemporary magnetic field. After movement of the magnetic poles, or periodic reversals of polarity, the remanent magnetization is preserved in the rocks and may be measured to aid identification of stratigraphical units and to assess their relative ages^[9].

palette. In a cave, a more or less flat protruding sheet of crystalline calcium carbonate spared during solution of the rock on each side of it^[10]. See also *blade*; *shield*. Synonym: *shield*.

palygorskite. A cave mineral — $(\text{Mg,Al})_2\text{Si}_4\text{O}_{10}(\text{OH})\cdot 4\text{H}_2\text{O}$ ^[11].

pan coefficient. Coefficient to correlate a high rate of evaporation in a pan to an evaporation rate from larger water bodies^[16].

panhole. See *solution pan*.

paragenesis. A type of cave passage development in which erosion of the passage floor is inhibited by the presence of an armoring layer of sediment, such that any dissolutional enlargement is dominantly upwards^[9]. Generally, an unproven and unsupported theory.

paragenetic cave. Cave passage, usually of canyon form, believed to be created by paragenesis. Passage formation by paragenesis is normally very difficult to prove, as later sediment removal leaves a passage that looks very similar to the far more common vadose canyon. It is thought that some of the larger canyons in the Flint Mammoth Cave System, USA, may have formed in this way^[9].

parahopeite. A cave mineral — $Zn_3(PO_4)_2 \cdot 4H_2O$ ^[11].

paraphreatic. A paraphreatic passage has an air surface under relatively low flow conditions, when drainage is within the capacity of its downstream continuation, but reverts to being water-filled (phreatic) under conditions of high flow or when the downstream drainage is temporarily impeded^[9].

parent material. Material from which soil or sediment was formed^[16].

park. (Arizona.) Shallow broad solution depression^[10].

particle. The smallest individual constituent of an aggregate^[16].

particulate transport. The movement of particles in subsurface water^[22].

parting. The separation of sedimentary rock along bedding planes^[16]. Synonyms: *bedding-plane*; *bedding-plane parting*. See also *bedding plane*.

partition. 1. A nearly vertical residual rock mass in a cave. 2. A continuous rock span across a cave^[10].

partitioning function. A mathematical relation describing the distribution of a reactive solute between solution and other phases^[22].

parts per million. An expression of concentration (ppm.) The weight per weight of a solution^[16].

passage. 1. Broadly, a passage is any negotiable part of a cave system, though the usage is commonly restricted to those elements that tend towards the horizontal rather than vertical or subvertical sections. Cave passages vary in size and shape, with the latter relating to the mode of origin and providing evidence of the nature of cave development mechanisms. Perhaps the largest passage in the world is Deer Cave, which is up to 170 m wide and 120 m high, in the Mulu karst of Sarawak^[9]. 2. A comparatively small underground opening made along fractures, fissures, and bedding-plane partings by running water but through which it is possible to pass^[20]. 3. In a cave, the opening between rooms or chambers^[10]. Synonyms: (French.) *galerie*; (German.) *Gallerie*, *Stollen*; (Greek.) *ypohios thiothos*; (Italian.) *cunicolo*, *galleria*; (Russian.) *hod*; (Spanish.) *galeria*; (Turkish.) *geçit*; (Yugoslavian.) *galerija*. See also *chamber*; *room*.

pathogenic bacteria. Disease-inducing bacteria^[16].

pavement. See *limestone pavement*.

peat. Decomposed matter, mainly vegetable^[16].

pebble. A smooth rounded rock fragment^[16].

Peclet number. A relationship between the advective and diffusive components of solute transport expressed as the ratio of the product of the average interstitial velocity, times the characteristic length, divided by the coefficient of molecular diffusion. Small values indicate diffusion dominance, large values indicate advection dominance^[22].

pearl. See *cave pearl*.

pediment. An inclined erosion surface covered with thin fluvial deposits^[16].

pellicular water. 1. The film of water left around each grain or fracture surface of water-bearing material after gravity drainage^[22]. 2. Water of adhesion^[22]. 3. Water that can be extracted by root absorption and evaporation but cannot be moved by gravity or by the unbalanced film forces resulting from localized evaporation and transpiration^[22].

peloid. A microscopic texture. A sedimentary grain composed of micrite carbonate irrespective of origin^[20]. Synonyms: (French.) *peleine*; (German.) *mikroskopisches, sedimentäres Gefüge*; (Greek.) *peloidís*; (Italian.) *peloida*; (Spanish.) *peloida*; (Turkish.) *peloid*. See *micrite*, *pelsparite*.

pelsparite. A microscopic texture. A limestone composed of pellets (peloids) in a matrix of cement^[20]. Synonyms: (French.) *pelsparite*; (German.) *Pelsarite, Kalkstein gefügt aus Kügelchen*; (Greek.) *pelsparítis*; (Italian.) *pelsparite*; (Spanish.) *pelsparita*; (Turkish.) *pelsparit*. See *peloids*.

pendant, rock pendant. One of a group of isolated similarly proportioned projections surrounded by a complex of connected cavities in the bedrock ceiling of a cave^[10]. Formed by the rapid, differential solution of the surrounding rock^[19].

pendular regime. A saturation regime where a porous medium has the lowest possible saturation in the form of pendular rings at grain contacts^[16].

penplain. A degradation surface without relief^[16].

pen trace. Ink, magnetic, or photographic line traced on the drum of a recording gage or meter^[16].

pepino hill. (Puerto Rican.) 1. Rounded or conical-shaped hill resulting from tropical humid karst action. Term generally replaced in Puerto Rico by *mogote*. 2. Elongate hill or ridge capped by *mogotes*^[10]. See *mogote*.

percent saturation. The ratio, expressed as a percentage, of (a) the volume of some fluid (water, gas, or oil) to (b) the total volume of intergranular space (voids) in a given porous medium. Synonymous with *degree of saturation*^[22].

perched ground water. Ground water separated from an underlying body of ground water by an unsaturated zone^[6]. See also *ground water, perched*.

perched karst spring. See *spring, perched karst*.

perched water table. Unconfined ground water separated from an underlying body of

ground water by unsaturated soil or rock. It may be either temporary or permanent.

percolate. To flow through saturated void space^[16]. The act of water seeping or filtering through soil or rock without a definite channel^[6].

percolation; percolation water. 1. Ground water moving slowly through the micro-fissure network of a limestone, most of which eventually joins a major cave conduit and flows more rapidly. In most environments percolation water enters the limestone through a soil cover. It is therefore high in carbon dioxide and has a major influence on limestone dissolution and later redeposition of calcite speleothems. Percolation water accounts for most of the storage in a limestone aquifer, responds slowly to flooding in comparison to sinkhole water, and is normally of high enough quality to provide a drinking-water supply^[9]. 2. The movement in laminar flow under hydrostatic pressure of water through the interconnected, saturated interstices of rock or soil, excluding movement through large openings such as caves and solution channels. 3. The downward movement of water through the unsaturated zone^[22]. 4. The downward flow of water in saturated or nearly saturated porous medium at hydraulic gradients of the order of 1.0 or less^[22]. 5. The movement of water through saturated interior pore space^[16].

percolation water. Autochthonous karst water that permeates directly through karst limestone without using a surface watercourse^[19].

perennial spring. See *spring, perennial*.

perennial yield. Sustained yield^[16].

periodic spring. See *spring, periodic*.

perforation. Holes or openings in well casing to permit water inflow into a well^[16].

permafrost. Ground that is perennially below the freezing point of water^[16].

permafrost karst. A nonkarst term. A pseudokarst developed in areas of permafrost because of melting of ice and frozen ground in a manner superficially similar to the solution of carbonate material in water. A general term embracing intrapermafrost karst, subpermafrost karst, and suprapermafrost karst^[20]. (French.) *karst de permafrost*; (German.) *Permafrost Karst, Pseudokarst*; (Greek.) *karst monímou pagthoú*; (Italian.) *pseudocarsismo di permafrost*; (Spanish.) *karst de permafrost*; (Turkish.) *aldaticı don karstı*; (Yugoslavian.) *permafrost křs (kras, karst)*.

permafrost table. The upper limit of permafrost^[16].

permanent hardness. Noncarbonate hardness^[16].

permanent wilting point. Saturation at which permanent wilting occurs^[16].

permeability. See *hydraulic conductivity; permeability, intrinsic*.

permeability barrier. See *barrier, permeability*.

permeability coefficient. The rate of flow of water through a unit cross-sectional area under a unit hydraulic gradient at the

prevailing temperature (field permeability coefficient) or adjusted to a temperature of 15NC^[22].

permeability, effective. The observed permeability of a porous medium to one fluid phase under conditions of physical interaction between this phase and other fluid phases present^[22].

permeability, intrinsic. 1. A measure of the ability of a medium to transmit a fluid through a porous medium. It is a function of the medium only and is proportional to the mean grain size diameter. 2. A measure of the relative ease with which a porous medium can transmit a fluid under a potential gradient, a property of the medium alone^[22]. 3. The property of a porous medium itself that expresses the ease with which gases, liquids, or other substances can pass through it^[22].

permeability, relative. 1. The ratio of the effective permeability for a given flow phase to the intrinsic permeability of the porous medium^[22]. 2. The ratio of the effective and specific permeabilities^[22]. 3. The ratio of permeability of one immiscible phase to intrinsic permeability in multiphase flow^[16].

permeability, specific. The permeability measured when the rock contains only one fluid^[22].

permeability tensor. Permeability in an anisotropic medium^[16].

permeability, transverse. Permeability measured perpendicular to the axis of a core sample^[16].

permeameter. A device used to measure the permeability of small samples^[16].

pervious. Permitting fluids to pass^[16].

petrography. The science of describing and identifying rocks^[16].

pH. A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. Originally stood for the words “potential of hydrogen”^[6].

phonolite. A type of volcanic rock, common as lava flows in some areas, that is capable of supporting the formation of extensive lava caves, including those on Mount Suswa in Kenya^[9].

photogeology. The interpretation of aerial photographs for geological purposes^[16].

photogrammetry. The preparation of maps and measurements from stereoscopic aerial photographs^[16].

phreas, phreatic water. (From the Greek word meaning “well.”) 1. The zone of saturated rock below the water table, within which all conduits and sub-conduits are water filled (sometimes referred to as the flooded, phreatic, or saturated zone). Commonly the phreatic zone is considered as being subdivided into an upper (shallow phreatic) zone and a lower stagnant phreatic zone^[9]. 2. Water in the zone of saturation; water below the water table^[10]. See also *ground water*.

phreatic cave. 1. Cave conceived and developed by dissolution, usually below the

water table, where all voids are water filled within the phreas. Phreatic caves may include loops deep below the water table, particularly in dipping limestone with widely spaced bedding-related fissures. Higher fissure densities, sub-horizontal geological guidance, or greater karstic maturity encourage shallow phreatic development just below the water table. Progressive abandonment of phreatic caves is usually in a downward sequence, as erosionally lowered valley floors intersect lower levels of the flooded system. Active phreatic cave segments, left perched for geological reasons after a general water-table lowering, are relatively common. Characteristics of phreatic caves are blind dissolution pockets on walls and ceilings, branching and looping of passages, and overall switchback gradients, as phreatic flow may be uphill under pressure. The most common passage form is a tube, though cross-sectional shape reflects local geological factors. A classic active phreatic cave is that behind the Fontaine de Vaucluse in France, while Hölloch, Switzerland, is a major system consisting mostly of relict phreatic passages^[9]. 2. Cave passage developed in the phreatic zone and still actively forming. Passages often appear as tubes.

phreatic decline. The downward movement of the water table^[16].

phreatic fluctuation. The fluctuation of the water table^[16].

phreatic lift. An active or abandoned phreatic conduit that carries or carried water upwards in a downstream direction^[9].

phreatic line. See *seepage line*.

phreatic rise. The upward movement of the water table^[16].

phreatic surface. See *water table*.

phreatic water. That part of the underground water in a karst limestone that lies within the zone of permanently saturated rock - the phreatic zone. Caves formed within this zone are known as phreatic caves^[19].

phreatic zone. 1. Those parts of the earth's crust in which all voids are filled with water under pressure greater than atmospheric^[22]. 2. That part of the earth's crust beneath the regional water table in which all voids, large and small, are ideally filled with water under pressure greater than atmospheric^[22]. When discussing a karst setting, it is preferable to use the term "phreatic zone" so as to avoid confusion regarding chemical saturation. Synonym: *saturated zone*. See also *zone of saturation*.

phreatophyte. Desert plants with deeply penetrating roots reaching the water table mainly along stream courses^[16].

physiography. The science of the origin and evolution of land forms^[16].

phytometer. A device used to measure the transpiration of plants embedded in soil^[16].

piedmont plain. A plain extending outwards from the base of a mountain system^[16].

piezometer. A device used to measure ground-water pressure head at a point in the subsurface^[22].

piezometric head. The sum of the pressure and elevation head^[16].

piezometric limit. The point within a given flow path below which the flow direction is influenced by hydrostatic pressure. In cases where flow is confined to a planar structure, the piezometric limit can be identified as a point where the flow path changes from a dip-oriented to a strike-oriented trend. The piezometric limit is determined both by discharge rate and geometry of the openings. Used to describe karst aquifers with a discontinuous piezometric surface^[14].

piezometric surface. 1. The imaginary surface to which water from a given aquifer will rise under its full static head^[10]. 2. Defined by the elevation to which water will rise in artesian wells or wells penetrating confined aquifers^[16]. See also *potentiometric surface*.

pillar. 1. Remnant of bedrock joining the cave floor and ceiling. Not to be confused with a column, which is a calcite deposit. Pillars are common in phreatic caves, formed by complexly looping ground-water flow, but may also be left as small oxbow cores of vadose origin. A spectacular group of pillars occurs in the ill-named Chamber of Columns in the Sof Omar cave, Ethiopia^[9]. 2. A column of rock remaining after solution of the surrounding rock. 3. A stalactite-stalagmite that reaches from roof to floor in a cave; more properly termed a column. 4. A tall thin stalagmite that does not reach the roof of a cave^[10]. See *column*; *rock pillar*.

pinnacle karst. 1. Tropical karst characterized by vertical rock blades fretted sharp by dissolution. It is practically indistinguishable from *arête karst* and *tsingi*, and includes the varieties known as *shilin*. The Pinnacles in the Mulu karst of Saraway

have rock blades up to 50 m high projecting through the rain forest canopy^[9]. 2. A tropical landscape of bare reticulated saw-topped ridges having almost vertical slopes and a relief of as much as 120 meters. The ridges rise above forest-covered depressions and corridors. Found in New Guinea at elevations or around 2,000 meters^[20]. Synonyms: (French.) *karst à pinacles*; (German.) *Pinnacle Karst*; (Greek.) *karst koriphón*; (Italian.) *carsismo a pinnacoli*; (Turkish.) *sivritepeli karst*. Compare *cone*, *cupola*, *tower karst*.

pinnacles. These are a particularly mature form of karren. The side walls are grikes with Rinnenkarren cutting across one another to form sharp edges and peaks that can reach several meters in height. Generally, pinnacles need a long time to form. They are common in the tropics and can attain great sizes^[3]. Often, they are covered. See also *debris karren*.

pipe. 1. A generally small, subcylindrical, vertical hole developed in an unconsolidated sedimentary deposit by the washing away of all or part of its fines content. Some pipes develop above points on a carbonate-rock surface, such as joint intersections, where ground-water seepage is locally concentrated. Pipes in chalk include cylindrical and conical masses of clay and sand that are neptunian fills of dissolutional dolines, shafts and caves; all shapes and sizes are commonly referred to as chalk pipes^[9]. 2. Small cylindrical hole in unconsolidated sediments, caused by removal of fine material by water^[10]. 3. A closed tubular conduit for fluid transport^[16].

pipng. 1. A process whereby a cavity or small conduit is developed in an

unconsolidated soil due to progressive sediment removal by seepage water. The cavity develops headwards, as the fines are removed first and the coarser material is then washed out of the growing cavity^[9]. Definition 1 is often incorrectly applied to the formation of sinkhole development — the migration of smaller particles through openings created by larger particles is of no consequence in terms of sinkhole development and should not be confused as such. 2. Formation of a passage by water under pressure in the form of conduits through permeable materials when the hydraulic head exceeds a certain critical value^[10]. 3. The mechanical washout of caves in gravels, soils, loess, etc., showing evidence of associated collapse.

pisanite. A cave mineral — $(\text{Fe,Cu})\text{SO}_4 \cdot 7\text{H}_2\text{O}$ ^[11].

pisolite, pisolith. See *cave pearl*.

pit. A deep hole, generally circular in outline, having vertical or nearly vertical walls^[10]. See also *jama*; *pothole* (definition 2); *shaft*.

pitch. Vertical or subvertical shaft or cave waterfall that normally requires rope, ladder, or equipment to pass; a term used by British cave explorers^[9].

piton. (French.) Limestone hill having sharply pointed peak^[10].

pitot tube. A device used to measure flow velocity via pressure differences^[16].

pitted plain. Plain having numerous small closely spaced closed depressions^[10].

plane of weakness. Surface or narrow zone with a shear (or tensile) strength lower than that of the surrounding material.

planimeter. An instrument that automatically determines irregular areas on a map^[16].

plateau. An elevated level land surface^[16].

pocket. Solution cavity in ceiling, floor, or walls of a cave, shaped like the interior of a round-bottomed kettle; unrelated to joints or bedding^[10]. See also *spongework*.

pocket valley. 1. The reverse of a blind valley, extending headwards into the foot of a calcareous massif. The upstream end is terminated by a cliff, frequently lunate, from whose base emerges a subterranean karst stream meandering across a flat, steep-sided valley below the resurgence^[19]. 2. A valley that begins abruptly and has no headwaters, having formed from and below the site of a spring^[9].

pocket storage. Water storage in depressions on the land surface^[16].

podzol. A light colored soil, usually found in forest regions^[16].

point-bar deposit. Sedimentation on the inside of a meander loop of a river or stream channel^[16].

point of inflection. The point where a curve changes slope^[16].

point source. Any discernable, confined, or discrete conveyance from which pollutants are or may be discharged, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, container, rolling stock,

concentrated animal feeding operation, or vessel or other floating craft^[22].

poise. A measure of viscosity.

pokrytyĭ karst. (Russian.) See *covered karst*.

polarization. The migration and separation of ions to the electrodes in a direct current electrolyte process giving rise to higher overall resistance^[16].

polje. (Slavic word for “field.”) 1. A large, flat-floored depression in karst limestone, whose long axis is developed parallel to major structural trends and can reach tens of kilometers in length. Superficial deposits tend to accumulate on the floor. Drainage may be by either surface watercourses (when the polje is said to be open) or swallow holes (a “closed” polje.) Their development is encouraged by any impedance in the karst drainage^[19]. 2. Polje or karst polje signifies the flat-bottomed lands of closed basins which may extend over large areas, as much as 1,000 km². The flat floor of the polje may consist of bare limestone, of a nonsoluble formation (and so with rolling topography), or of soil. The polje will show complex hydrogeological characteristics such as exurgences, swallow holes, estavelles, and lost rivers. In colloquial use, the term polje is applied to flat-bottomed lands that are overgrown or are under cultivation^[20]. 3. Large flat-floored closed karst depression, with sharp slope breaks between the commonly alluviated floor and the marginal limestone. Streams or springs drain into poljes and outflow is underground through ponors. Commonly the ponors cannot transmit flood flows, so many poljes turn

into wet-season lakes. The form of some poljes is related to the geological structure, but others are purely the projects of lateral dissolution and planation. The Dinaric Karst has many poljes; the Livansko polje is around 60 km long and 7 km wide. The word is Slovene (common also to other Slav languages) for a field, reflecting the agricultural value of the alluvial polje floor soils^[9]. Synonym: *interior valley*; (French.) *polje*; (German.) *Polje*; (Greek.) *polye*; (Italian.) *polje*; (Russian.) *polje*; (Spanish.) *polje*; (Turkish.) *gölova, polye*; (Yugoslavian.) *polje*. See also *karst polje*.

pollutant or contaminant. Includes, but is not limited to, any element, substance, compound, or mixture including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingesting through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation in such organisms or their offspring^[22].

polluted water. Water that has become contaminated by sewage or other contaminants such that the water quality has become severely degraded.

pollution. 1. Specific impairment of water quality by agricultural, domestic, or industrial wastes (including thermal and atomic wastes), to a degree that has an adverse effect upon any beneficial use of water^[22]. 2. The addition to a stored body of water of any material that diminishes the

optimal economic use of the water body by the population it serves, and has an adverse effect on the surrounding environment^[22].

pollution abatement. All measures taken to prevent or to protect against pollution^[16].

polygonal karst. 1. A karst area where the surface is completely pitted with closed depressions, the divides of which form a crudely polygonal network. Especially common in humid tropical cone-karst terrain, but also found in well-formed temperate doline-karst terrain^[10]. 2. A type of karst in which numerous closed depressions are separated by dividing ridges that impose a crudely polygonal appearance upon the landscape^[9].

pond. A small body of surface water^[16].

ponded water. Water held in a depression by a barrier^[16], such as breakdown in a cave system.

ponor. (Slavic.) 1. Hole or opening in the bottom or side of a depression where a surface stream or lake flows either partially or completely underground into the karst ground-water system. A sea ponor is where sea-water flows or is drawn into an opening by a vacuum in karstified rock^[20]. 2. Hole in the bottom or side of a closed depression through which water passes to or from an underground channel^[10]. Synonyms: (British.) swallet, swallow hole, stream sink; (French.) *ponor, aven, gouffre, perte*; (German.) *Schlund, Saugloch, Schlinger, Ponor*; (Greek.) *katavothra*; (Italian.) *inghittitoio, capovento*; (Russian.) *ponor*; (Spanish.) *sumidero, ponor, pérdida*; (Turkish.) *su yutan*;

(Yugoslavian.) *ponor, utok, požiralnik, pivka*. See also *swallow hole*.

ponornica. See *lost river*.

pool deposit. Crystalline material deposited in an isolated pool in a cave^[10].

pore. Small void space in rock or unconsolidated material of soil particles. See also *interstice*^[16].

pore deposit. Mineral matter deposited on the interior of a cave from water entering the cave so slowly through pores and cracks that it does not form drops^[10].

pore entry radius. The radius of a flow channel at pore entry, usually smaller than the average pore radius^[16].

pore pressure. The pressure of water in pores of a saturated medium^[16].

pore space. 1. The total space not occupied by solid soil or rock particles^[22]. 2. The space occupied by voids containing gases or liquids in soil or rock samples^[16]. See also *interstice; porosity; porosity, effective; porosity, primary; porosity, secondary*.

pore velocity. See *velocity, average interstitial*.

porosimeter. A device used to measure porosity^[16].

porosity. 1. The ratio of the aggregate volume of interstices in a rock or soil to its total volume; generally stated as a percentage^[10]. 2. The ratio, usually expressed as a percentage, of the total volume of voids of a given porous medium

to the total volume of the porous medium^[22]. 3. The volume percentage of the total bulk not occupied by solid particles^[22]. See also *porosity, effective; porosity, primary; porosity, secondary; porosity, tertiary*.

porosity, absolute. Porosity established by taking into account all interconnected and nonconnected or isolated void volumes^[16].

porosity, effective. 1. The ratio, usually expressed as a percentage of the total volume of voids available for fluid transmission to the total volume of the porous medium^[22]. 2. The ratio of the volume of the voids of a soil or rock mass that can be drained by gravity to the total volume of the mass^[22]. 3. The amount of interconnected pore space and fracture openings available for the transmission of fluids, expressed as the ratio of the volume of interconnected pores and openings to the volume of rock. See also *porosity; porosity, primary; porosity, secondary; porosity, tertiary*.

porosity, primary. Porosity of some lithological material that developed while the rock was forming. See also *interstice; pore; pore space; porosity; porosity, effective; porosity, secondary*.

porosity, secondary. Porosity of some lithologic material, such as joints and fractures, that has developed after the rock was initially formed, and may be capable of enlargement by dissolution processes. See also *pore; pore space; porosity, effective; porosity, primary; porosity, tertiary*.

porosity, tertiary. Porosity caused by solutional enlargement of secondary

porosity. See also *pore; pore space; porosity; porosity, effective; porosity, primary; porosity, secondary*.

porous. Having numerous interstices, whether connected or isolated.

porous medium. Any medium containing interdispersed void space^[16].

porthole. A nearly circular natural opening in a thin rock wall in a cave^[10]. See also *window*.

potable water. Water that is suitable for human consumption^[22].

potamology. The study of streams.

potential. Any of several different scalar quantities, each of which involves energy as a function of position or of condition; e.g., the fluid potential of ground water^[22].

potential density. 1. The density of a unit of water after it is raised by an adiabatic process to the surface, i.e., determined from in-situ salinity and potential temperature^[22]. 2. Density that would be reached by a compressible fluid if it were adiabatically compressed or expanded to a standard pressure^[22].

potential drop. The difference in total head between two equipotential lines^[22].

potential evapotranspiration. Evapotranspiration occurring under adequate soil-moisture supply at all times for given temperature and humidity conditions^[16].

potential flow. Irrotational flow occurring in a conservative force field or potential field^[16].

potentiometer. An instrument used to measure voltage differences^[16].

potentiometric field. As used in karst hydrology, a discontinuous highly irregular surface representing the static ground-water head as indicated by the level to which water rises in a selected piezometer. In some piezometers, the water-level rise will be greatly different from other piezometers (either higher or lower), or may be nonexistent altogether.

potentiometric surface. An imaginary surface representing the total static head of ground water and defined by the level to which water will rise in a piezometer^[22]. Replaces the term “piezometric surface.”

pothole. 1. A single shaft, or an entire cave system that is dominantly vertical. It is also used to describe a single erosional bowl or moulin, rounded mainly by the swirling current, in a stream bed^[9]. 2. A small rounded hole pipe worn into the bedrock of a streambed, or on the coast, or at a waterfall, by sand, gravel, and stones spun around by the current in evorsion or mill action^[20]. 3. Term used in England for vertical or steeply inclined shaft in limestone^[10]. Synonyms: (French.) *marmite de géant, aven*; (German.) *Kolk, Strudelloch*; (Greek.) *strongíli opí is petróthi kítin révmatos*; (Italian.) *marmitta dei giganti*; (Russian.) *karstovaja sahta*; (Spanish.) *marmita de gigante, pilancón*; (Turkish.) *dev kazani*; (Yugoslavian.) *erozioni kotas*. See also *pit, shaft*.

potholer. (British.) Explorer of openings in karst formations with emphasis on vertical and steep openings; somewhat of a slang term^[20]. Synonyms: (French.) *spéléologue*; (German.) *Speläologe, Höhlenforscher*; (Greek.) *erevna karstikon engelon*; (Italian.) *speleologo*; (Spanish.) *espeleólogo, explorador de simas*; (Turkish.) *dev kazancı*; (Yugoslavian.) *speleolog, jamar*. See *speleologist, caver*.

potholing. 1. The process of scouring holes in rock in stream beds or near the strand line by rapid rotation of trapped pebbles or cobbles; evorsion^[10]. 2. (British.) See *caving*.

pozo. (Spanish.) See *sima*.

precipitation. 1. Water precipitating in liquid or solid form from the atmosphere^[16]. 2. The growth and development of crystals from solutions that are supersaturated with respect to various minerals.

precipitation excess. That part of precipitation that contributes directly to runoff^[16].

precipitation gage. An instrument used to measure the amount of precipitation per unit area^[16].

pressure. The force exerted across a real or imaginary surface divided by the area of that surface.

pressure cell. A pressure measuring and transducing device^[16].

pressure cell. The pressure difference occurring between two points along a stream line in a flow system^[16].

pressure flow tube. Gallery with water flowing under pressure including differential gravity head and artesian pressure^[20]. Synonyms: (French.) *galerie en conduite forcée*; (German.) *Druckströmungsröhre*, *Karstgerinne*; (Greek.) *ypoghion ytnatagogos*, *ypopiesin*; (Italian.) *condotta forzata*; (Russian.) *karstovij kanal s napornimi vodami*; (Spanish.) *galería (o tubo) saturada*; (Turkish.) *basınçlı su mecrası*; (Yugoslavian.) *kanal s vodom pod tlakom*. See also *conduit*; *streamtube*.

pressure head. Hydrostatic pressure expressed as the height of a column of water that the pressure can support at the point of measurement^[22]. See also *head*, *static*; *pressure*, *hydrostatic*.

pressure, hydrostatic. The pressure exerted by the weight of water at any given point in a body of water at rest^[22].

prism storage. The storage of water in a river channel or reservoir in prism above the original water level^[16].

probe. A sensing instrument used to take measurements at the interior of a relatively unaccessible system^[16].

proto-cave. Natural void that links a potential input point and an output point within an aquifer, but which is still too small to be entered by humans^[9].

prusiking. The art of ascending a standing line (rope) by a caver with prusik knots^[13] as opposed to the use of a mechanical ascender. See also *ascender*; *knots*; *mechanical ascender*; *prusik knot*; *standing line*.

prusik knot. A knot tied by looping a smaller diameter rope around a larger standing line (rope) that has the property of sliding with no load on the knot, but will hold when it is loaded (e.g., when the weight of a caver is applied)^[13]. See also *ascender*; *mechanical ascender*; *prusiking*; *standing line*.

pseudokarren. These are karren-appearing features that form mostly on insoluble silicate rocks by means of weathering processes. They appear as a rounded type of Rinnenkarren and less frequently as an atypical form of solution pan^[3]. See also *karren*; *Rinnenkarren*; *solution pan*.

pseudokarst. 1. Terrane with features similar to karst but formed in nonsoluble rocks, as by melting of permafrost or ground ice, collapse after mining, and outflow of liquid lava from beneath its solidified crust^[20]. 2. Karstlike terrane produced by a process other than the dissolving of rock, such as the rough surface above a lava field, where the ceilings of lava tubes have collapsed. Features of pseudokarst include lava tunnels, lava tubes, lava stalactites, and lava stalagmites^[10]. 3. A landscape containing karstlike features such as caves and dolines, but not formed by bedrock dissolution as in true karst. Pseudokarst embraces volcanic landscapes with lava caves, cryokarst, or thermokarst formed by ground-ice melting in a permafrost environment, and situations where mechanical soil piping has occurred, producing depressions and pipes, as occur commonly in areas of loess cover^[9]. Synonyms: (French.) *pseudokarst*; (German.) *Pseudokarst*; (Greek.) *psevthokarst*; (Italian.) *pseudocarsismo*; (Russian.) *psevdokarst*; (Spanish.) *pseudokarst*; (Turkish.) *aldatıcı karst*; (Yugoslavian.) *pseudokŕs*, *pseudokras*,

pseudokarst, navidezni kras. See *lava cave, lava karst, pahoehoe.*

pyrrhotite. A cave mineral — $\text{FeS}^{[11]}$.

pseudo-breccia. A type of limestone resembling a breccia, in which angular limestone fragments are cemented together by limestones of different composition. Pseudo-breccias are common in many preserved limestone sequences and may owe their origin to the dissolutional removal of originally interbedded and interstitial sulfate minerals followed by breakup and redistribution of the residual carbonate component^[9].

psychrometer. Apparatus designed to measure relative humidity indirectly^[16].

puddle. Water collecting in very small surface depressions^[16].

pumping test. A test designed to determine aquifer characteristics by pumping a well and plotting the drawdown curves of observation wells for comparison with theoretical curves.

pycnometer. A bottle with an accurately determined volume for density determinations^[16].

pyrite. Iron sulfide mineral (FeS_2) also known as iron pyrites and fool's gold. Pyrite occurs in trace amounts in many sedimentary rocks. It may be locally common in dark carbonaceous limestone and in thin noncarbonate beds such as shales, coals, and wayboards. Pyrite may break down spontaneously, with or without bacterial mediation, to form sulfates, particularly sulphuric acid, that may be involved in early speleogenesis^[9].

Q

quagmire. A wet unstable land area^[16].

quartz. A crystal form of silicon dioxide
(SiO₂)^[16].

quiet reach. The reach of a river with no
features disturbing the flow pattern^[16].

R

radial flow. 1. Radial flow into or out of a well under ideal circular boundary conditions^[16]. 2. The flow of ground water in all directions in response to recharge entering the subsurface at or near the top of a ground-water plateau. This condition occurs most often through point recharge entering the subsurface via sinkholes in karst terranes.

radioactive tracer. A tracer used in hydrological direction and velocity determinations^[16]. The two most common types are tritium and deuterium.

radioactivity log. A log measuring radioactivity in a borehole^[16].

radioisotope. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation^[22].

radionuclide. A radioisotope^[22].

radionuclide retardation. The process or processes that cause the time required for a given radionuclide to move between two locations to be greater than the ground-water travel time, because of physical and chemical interactions between the radionuclide and the geohydrologic unit through which the radionuclide travels^[22].

radius of influence. The radial distance from the center of a well bore to the point where there is no lowering of the water table or potentiometric surface (the edge of its cone of depression)^[6].

raft. A thin sheet of crystalline calcite supported by surface tension on a cave pool

or lake. The calcite is precipitated mainly in response to evaporation of the pool water, and rafts are therefore found mainly in caves in arid regions or caves with powerful through draughts.

rain. Liquid precipitation of atmospheric water in the form of droplets^[16].

rainfall excess. That portion of rainfall that contributes directly to runoff^[16].

rainfall intensity. The volume or depth of rainfall per unit time^[16].

rain gage. An instrument used to measure the height of rainfall^[16].

rain gage network. An areal distribution of rain gages^[16].

rain intensity. The intensity of rainfall expressed in depth per time (in/hr)^[16].

randpolje. An enclosed plain at the edge of a karst area receiving surface water from the nonkarstic area. The water drains out through underground passages in the karst area. The plain is thus completely enclosed by higher ground. Compare *blind valley*; *karst margin plain*^[10].

rappel. The art of descending a rope using some sort of friction between the rope and the rappeller to control the rate of descent^[13]. See also *carabiner*.

rappel rack. A long U-shaped steel bar that holds several brake bars and is used for rappelling^[13]. See also *rappel*.

rappel spool. One of the devices used to create friction between a rappeller and the

- rope, consisting of a spool on which the rope can be wrapped around several times^[13]. See also *rappel*.
- rapid.** A stream section with a notably higher flow velocity than in adjoining parts^[16].
- rapid flow.** Open channel flow with a Froude number greater than unity^[16]. See also *Froude number*.
- rate of draft.** The rate at which water is required for use (demand)^[16].
- rate of infiltration.** The maximum rate at which soil can absorb water^[16].
- rating curve.** The graphic relationship of stage to discharge^[16].
- rational formula.** An equation relating runoff intensity and area to a runoff coefficient^[16].
- ravine.** A small erosional depression^[16]. See *chasm*.
- raw sewage.** Untreated sewage.
- raw water.** Untreated water^[16].
- reaction path modeling.** A simulation approach to studying the chemical evolution of a (natural) system^[22].
- rebound.** An upward movement of soil as a consequence of a decrease in effective stress. In fine-grained soils, rebound is usually much less than the amount of compaction, since compaction is mostly irreversible^[21].
- receiver.** That part of a remote measuring system that receives incoming data or impulses^[16].
- receiving surface.** A surface receiving precipitation or radiation^[16].
- recessional moraine.** A moraine deposited by a retreating glacier^[16].
- recession curve.** The falling limb of a hydrograph curve^[16].
- recession flow.** The flow that occurs after rainfall has ended^[16].
- recession segment.** That part of a hydrograph that represents the withdrawal of water from storage^[16].
- recharge.** 1. The process of addition of water to the saturated zone^[22]. 2. The artificial replenishment of a depleted aquifer by injection or infiltration of water from the surface^[16].
- recharge, allogenic.** Recharge derived from runoff of neighboring or overlying nonkarst rocks that drains into a karst aquifer. Diffuse allogenic recharge is used to describe the slow percolation of recharge when runoff into direct input points is reduced in magnitude, whereas concentrated allogenic recharge is used to describe the concentrated recharge that occurs by runoff into large fractures, sinkholes, and sinking streams.
- recharge area.** An area in which water reaches the zone of saturation by surface infiltration^[22]. See also *intake area*.

recharge, autogenic. Recharge derived from precipitation directly onto the karst landscape. Diffuse autogenic recharge is used to describe the slow percolation of recharge through a myriad of small openings, whereas concentrated autogenic recharge is used to describe the concentrated recharge that occurs by flow into large fractures, sinkholes, and sinking streams.

recharge capacity. The ability of the soils and underlying materials to allow precipitation and runoff to infiltrate and reach the phreatic zone^[22].

recharge line. A series of recharge wells arranged in linear fashion to approximate a line source^[16].

recharge pit. A large diameter well or shaft for recharge under gravity^[16].

recharge water. Water used for replenishment of a depleted aquifer^[16].

recharge well, absorbing well, diffusion well, inverted well. A well that is used to recharge water back into an aquifer. Commonly used when aquifer depletion, saltwater intrusion, and contaminant migration are problems.

recipient. A vessel receiving liquids in volume measurements^[16].

reclamation. To reclaim land after abusive effects such as strip mining.

recorder. An instrument designed to continuously or intermittently record measurements^[16].

recovery. The water-level rise in a well occurring upon the cessation of discharge from that well or an observation well.

recovery method. A pumping test analysis method in which both drawdown and recovery of head after cessation of pumping are observed and plotted for the same observation well^[16].

recrystallization. A new formation of crystals from solid rock material^[16].

reculée. See *pocket valley*.

redox. A chemical reaction in which an atom or molecule loses electrons to another atom or molecule. Also known as oxidation-reduction. Oxidation is the loss of electrons; reduction is the gain of electrons^[6].

redox potential (Eh.) Oxidation-reduction potential^[16].

reef. A dissected ridge of rocks totally or partially submerged in sea water; often of organic origin^[16].

regelation. The melting of ice under pressure and subsequent freezing^[16].

region of dispersed water. The diffuse interface between fresh water and sea water caused by mixing in a coastal aquifer^[16]. See also *transition zone*.

regolith. A general term for the layer of fragmental and unconsolidated rock material that nearly everywhere forms the surface of the land and overlies or covers the bedrock^[6].

regosol. Dry sandy soil^[16].

regression line. A curve fitted to all mean values of one variable^[16].

rejuvenation. A process that interrupts an active erosional or development cycle and initiates a new cycle. Rejuvenation is most commonly achieved in the karst and speleogenesis context by erosional base-level changes caused by relative uplift (or sea-level fall) or by local water-table changes caused by downcutting of surface valleys intercepting deeper drainage lines^[9].

relative humidity of atmosphere. The ratio of absolute humidity to the maximum possible saturation at given conditions^[16].

relative permeability. See *permeability, relative*.

relict cave. Abandoned, inactive cave segment, left when the water that formed it is diverted elsewhere, normally through rejuvenation, continuing cave development and increasing karstic maturity. Relict unmodified phreatic passage segments are abandoned in the vadose zone, where they may remain dry, retaining a typical phreatic morphology, or be invaded and modified to a keyhole profile by new streams. Ages of relict caves vary greatly and because of a lack of stream-flow breakdown and speleothem deposition may become the dominant processes. Relict caves are commonly referred to incorrectly as fossil caves^[9].

relict karst. A karst area that exists within the contemporary system, but has been removed from the situation in which they

developed, usually as a result of base-level changes.

relief. Elevation differences in topography of a land surface^[16].

relief intensity. The average altitude difference between the highest point of a basin and the valley bottom^[16].

replenishment. The restoration of water in a depleted aquifer^[16].

resequent river. A river flowing according to a consequent drainage pattern but at a lower level than the original slope^[16].

reservoir. 1. A recipient for the collection of small amounts of liquid^[16]. 2. A surface water impoundment^[16].

reservoir evaporation. Evaporation from the free surface of impounded water bodies^[16].

reservoir lake. A lake obtained by the impoundment of water for storage purposes^[16].

residual clay. Clay or sandy clay remaining on a rock surface after removal of calcium carbonate by solution. Compare *terra rossa*^[10].

residual drawdown. The rise in water level in a well in response to cessation of pumping.

residual hill. See *emergence*.

residue. Solids remaining after evaporation^[16].

resurgence. 1. Re-emergence of karst ground water, a part or all of whose waters are derived from surface inflow into ponors at higher levels^[20]. Point at which an underground stream reaches the surface and becomes a surface stream. In European literature, the term is reserved for the re-emergence of a stream that has earlier sunk upstream; the term “exurgence” is applied to a stream without known surface headwaters^[10]. Synonyms: (French.) *résurgence*; (German.) *Karstquelle*; (Greek.) *kephalari*; (Italian.) *risorgenza*; (Russian.) *vihod karstovih vod*; (Spanish.) *resurgencia*; (Turkish.) *suçikan*; (Yugoslavian.) *krški izvor (vrela), obrh*. See *emergence*. Compare *exurgence*.

retardation factor. The ratio of the average linear velocity of ground water to the velocity of the retarded constituent at $C/C_o=0.5$ ^[22].

retention. 1. The detention of water on surface depressions or in subsurface void space. 2. The retention of water in pores against gravity^[16].

reverse fault. A fault where relative movement of the hanging wall has occurred in the upward direction^[16].

Reynolds number. A numerical quantity used as an index to characterize the type of flow in a hydraulic structure in which resistance to motion depends on the viscosity of the liquid in conjunction with the resisting force of inertia. It is the ratio of inertia forces to viscous forces, and is equal to the product of a characteristic velocity of the system (e.g., the mean, surface, or maximum velocity) and a characteristic linear dimension, such as

diameter or depth, divided by the kinematic viscosity of the liquid; all expressed in consistent units in order that the combinations will be dimensionless. The number is chiefly applicable to closed systems of flow, such as pipes or conduits where there is a free water surface, or to bodies fully immersed in the fluid so the free surface need not be considered^[1]. See also *Chézy equation*; *Froude number*; *Manning equation*.

rhodamine dye, sulpho rhodamine dye. Orange dyes used in environmental tracing studies that fluoresce red when held under a black light. See also *fluorescent dyes*.

rice paddy. In a cave, a terraced rimstone pool^[10].

ridge. An elongated narrow elevation^[16].

rift. 1. A cave passage that is relatively high and narrow. Generally rifts are straight or nearly so, reflecting that they are commonly guided by, and developed along, vertical or subvertical fissures, joints, and faults^[9]. 2. A long narrow high cave passage controlled by joints or faults^[10].

rift valley. A surface depression due to the formation of graben block faulting^[16].

rill. 1. Small solution groove on surface exposures of limestone; most common in arid or semiarid areas^[10]. 2. Small channel cut by flowing water in the floor, wall, or ceiling of a cave^[20]. 3. The smallest category of stream in any terrane^[20]. Synonyms: (French.) *traces de ruissellement*; (German.) *Rinne, Kerbe*; (Greek.) *ridkion*; (Italian.) *solchi di*

ruscellamento; (Spanish.) *arroyuelo*;
(Turkish.) *küçük dere, oluk, ark*.

Rillenkarrren. (German.) Solution flutes that occur only in places where fresh unspent precipitation is active and end where the water attains too high a content of lime or where water is added. Their length increases with slope, temperature, and rainfall; eventually reaching 1 m and more in the tropics, up to 50 cm, and as an exception, 100 cm in the Alps. Their width extends from 1 to 3 cm. They lie together in rows with no space between, with sharp intermediary ridges of no more than 1 cm in height. They increase at all freely exposed peaks and ridges where fresh rainwater alone is at work. The grooves gradually flatten out to a smooth surface. Their theory of origin is unknown.^[3] Synonyms: (German.) *Kannelierungen*; *solution flute*; and *firstkarrren*.

Rillenstein. (German.) Microsolution grooves and pitting on rock surface^[10].

rimstone. 1. A wall-shaped deposit around springs and below cascades which impounds water in pools. Its formation is due to precipitation from saturated bicarbonate waters^[20]. 2. Calcareous deposits formed around the rims of overflowing basins, especially in caves^[10]. Synonyms: (French.) *gour*; (German.) *Sinterbecken*; (Greek.) *fráigma*, *epiphliomatos*; (Italian.) *vasche d'incrostazione*; (Russian.) *natecnaja plotina*; (Spanish.) *dique travertínico*; (Turkish.) *sedde, kenartaşı*. See *constructive waterfall*, *rimstone barrage*, *rimstone pool*.

rimstone barrage, rimstone barrier, rimstone dam. A wall-shaped deposit that impounds pools of water in caves, around springs, and in cascades of streams saturated with calcium bicarbonate^[10]. Synonym: (French.) *gour*. See also *rimstone*; *rimstone pool*.

rimstone pool. A pool sited on a cavern floor and enclosed by a rim of carbonate reprecipitated from the karst water in the pool at points locally favoring the release of carbon dioxide^[19]. See also *rimstone*; *rimstone barrage*.

Rinnenkarrren. (German.) Solution grooves that form where runoff water is collected in streams. If the whole surface is moistened, the amount of water increases downwards, with the result that the grooves are widened and deepened at the bottom. This distinguishes them from other similar forms. When the slope is slight they are coiled, but become straighter with increasing inclination. They are sometimes interpreted to be subcutaneous forms that develop below soil cover, but this is believed to be a rare occurrence. They are found in all climates. In arid zones, they exist as relics of the past when the climate was damper^[3].

ripple mark. A wavelike sculpture on water covered sand surfaces obtained by wave action^[16].

rise. (Jamaican.) Spring rising from fractures in limestone. Point at which an underground stream comes to the surface^[10].

rise pit. An artesian spring rising up through alluvium accumulated in an earlier surface valley phase and often fringed, except on

the outlet side, by a minor levee deposited as the force of the vertical discharge dissipates at the surface^[19].

riser. A pipe through which liquid rises in a well^[16].

riser pipe. A pipe through which water is raised in a production well^[16].

rising. 1. The resurgence of an underground watercourse, usually at the base margin of the calcareous massif, although in the instance of a blind valley the rising has eroded headwards for some distance. Each rising accounts for the collective discharge of several sinks and in this way has a relatively high discharge as the sole drainage outlet for a large area. If the water issues freely, the rising is said to be “free-flowing,” but if it issues under pressure, the terms “artesian,” “forced,” or “vauclosian spring” are used (after the type-example of the resurgence of the Sorgue river at Vaucluse in France)^[19]. 2. An issue of water from massive limestone that cannot be classed with certainty as either a resurgence or a spring^[20]. Synonyms: (French.) *émergence*; (German.) *Ausflußstelle*, *Karstquelle*; (Greek.) *kephalari*; (Italian.) *sorgente*; (Russian.) *vihod karstovih vod*; (Spanish.) *emergencia*; (Turkish.) *yüzeye yükseliş*; (Yugoslavian.) *krško vrelo*, *krški izvor*, *obr.* See also *emergence*; *exurgence*; *resurgence*.

rising segment. That part of a hydrograph curve that represents a rise in water level as a result of precipitation^[16].

river. A natural water course through which runoff reaches the sea^[16].

river bed. The channel of a river covered by water^[16].

river reach. A particular segment of a river^[16].

river swamp. A swamp in lowlands adjoining a river^[16].

river system. The system of a main river that includes all its branches and tributaries^[16].

river terrace. A level land terrace formed in a valley by fluvial erosion or aggradation^[16].

rivulet. A very small stream^[16].

rock. Consolidated mineral matter of igneous, sedimentary, or metamorphic origin^[16].

rock fall. See *cave breakdown*.

rock formation. A lithologically or structurally distinct part of the lithosphere^[16].

rock-hill. See *karren*, *rill*.

rock milk. Less common synonym for moonmilk^[9]. See *moonmilk*.

rock pendant. See *pendant*.

rock pillar. A residual isolated mass of bedrock linking the roof or overhanging wall and floor of a cave, in contrast with a column, which is composed of dripstone or flowstone^[10]. See *column*; *pillar*.

rock pinnacle. A tall sharp projection of bedrock rising from the floor of a cave^[10].

rock shelter. 1. Shallow cave under an overhanging rock ledge. Many sea caves are rock shelters. Also found in limestone and other rock types where streams have undercut their banks at bends, or where there has been abrasion by blowing sand. Common in tropical areas at places where a secondarily hardened layer of limestone forms a ledge that projects over unindurated limestone^[10]. 2. A wide but shallow cavity in any rock; in carbonate rock often formed below a noncarbonate layer^[20]. Synonyms: (French.) *abri sous roche, balme, baume*; (German.) *Halbhöhle, weite aber flache Höhle*; (Greek.) *kataphyion*; (Italian.) *riparo sotto roccia, androne*; (Spanish.) *abrigo, balma*; (Turkish.) *kaya siğinaği*; (Yugoslavian.) *potkapina, okapina, polupečina, spodmol, zijalka*.

rock system. Rocks deposited during a given geological time period^[16].

rock terrace. A terrace formed by erosional action and denudation^[16].

rock texture. The geometrical aspects and arrangement of the component particles of a rock^[16].

rockfall. The falling of bedrock from a cliff or steep slope^[16].

romanechite. A cave mineral — $\text{BaMn}_9\text{O}_{16}(\text{OH})_4$ ^[11].

roof crust. Flowstone deposited on ceilings of caves from thin films of water, which have crept over the rock from pore or crack sources^[10].

roof drainage. Precipitation runoff from roofs.

roof pocket. Blind upward extension into the ceiling of a cave passage, commonly enlarged by dissolution along a transverse fracture, and less extensive than an aven or chimney^[9].

roof slab. See *ceiling slab*.

room. A part of a cave system that is wider than a passage^[10]. Synonym: (British.) *chamber*.

root karren. These are small, relatively flat karrens that are formed beneath compact soils where roots etch into the limestone^[3]. See also *covered karren*; *wave karren*.

root zone. The zone in a soil profile penetrated by plant roots^[16].

rotating meter. A stream velocity meter that transforms stream momentum into angular momentum by vanes and rotor^[16].

roughness. An unevenness of surfaces giving rise to high flow resistances^[16].

roughness coefficient. A coefficient that describes roughness of a channel bed^[16].

round karren. See *Rundkarren*.

roundness. The degree to which a sand grain approaches spherical shape^[16].

roul, to. The action of predicting and directing of flood waves through a channel system^[16].

run dry, to. The cessation of flow from a well or spring^[16].

Rundkarren. (German.) 1. Karren forms with rounded edges; formed by soil water that cannot flow freely because of the tightness of soil pores and thus corrodes away all edges and points. The small karren forms disappear; grooves and grikes are widened and deepened. One or two centuries after being laid bare, the earlier rounded edge is only just recognizable, so round karren and their remains provide evidence of an earlier soil covering^[3]. 2. Karren form comprising rounded channels, commonly 50-500 mm deep and wide and separated by rounded ridges. Rundkarren are the characteristic dissolutional form created beneath superficial material such as sandy till, peat or other soil, or beneath a cover of plants or lichen^[9]. Synonym: *round karren*. See also *Karren*.

runoff. 1. The discharge of water through the surface streams of a drainage basin^[16]. 2. The sum of surface runoff and groundwater flow that reaches a stream^[16].

runoff coefficient. A dimensionless coefficient to estimate runoff as a certain percentage of storm rainfall^[16].

rupture. That stage in the development of a fracture where instability occurs. It is not recommended that the term “rupture” be used in rock mechanics as a synonym for “fracture.”

S

sabbath. See *hardpan, nari*.

safe yield. The amount of water that can be safely withdrawn from an aquifer without causing undue effects such as aquifer depletion.

safe yield of stream. The lowest dry weather flow of a stream^[16].

saline spring. See *spring, saline*.

saline water. Water that generally is considered unsuitable for human consumption or for irrigation because of its high content of dissolved solids. Generally expressed as milligrams per liter (mg/L) of dissolved solids, with 35,000 mg/L defined as sea water, slightly saline is 1,000-3,000 mg/L, moderately saline is 3,000-10,000 mg/L, very saline is 10,000-35,000 mg/L, and brine is more than 35,000 mg/L^[22].

salinity stratification. The stratification of water in estuaries because of salinity-density differences^[16].

salt dome. A domelike intrusion of a mobile salt core into sedimentary rock^[16].

salt karst. Areas in which karst landforms are developed upon halite or halite-rich rock, which are generally small and limited to arid regions, are referred to as salt karst. Except in desert regions, dissolution of rock salt occurs in buried, interstratal, situations, and the effects of such dissolution at the surface include subsidence pipes or wider subsidence areas, such as those represented by the meres and “flashes” in the Cheshire Plain, England^[9].

salt lake. A lake containing high salt concentrations and usually not having any outflow^[16].

salt tolerance. The resistance of crops to salt concentration^[16].

saltation. Solid matter transported by a stream by the action of leaping movement over the stream bed. See also *saltation load*.

saltation load. The solid matter transported by streams^[16].

saltwater intrusion. The movement of salt water into fresh water aquifers^[22].

sampling. The taking of small quantities of water or porous media for analysis^[16].

sand. Unconsolidated detrital rock material^[16].

sand pipe. See *solution pipe*.

sand stalagmite. A stalagmite formed on sand and made of calcite-cemented sandstone^[10].

sandstone caves. Most natural sandstone caves are surface river-cut notches at the foot of rock cliffs, or left partway up the cliff by later downcutting. This origin accounts for most of the caves once inhabited by the Pueblo Indians in the sandstone cliffs of the western USA. True caves do occur in sandstone, and some of these appear to be at least partially of dissolutional origin. Their existence probably reflects matrix leaching by ground water moving through zones of especially high primary porosity and permeability.

Though sandstones with a calcite matrix cement are more prone to such development, even siliceous cement, which has a very low solubility in water, may be removed during a sufficiently long time span. The sandstone caves of the Sarisarinama Plateau, Venezuela, may be a special case of this type of development. These include shafts 300 m in diameter and 200 m deep, and passages up to 500 m long. They were probably cut in the quartz sandstone by underground streams, after early leaching of the cement by hydrothermal solutions, and the shafts have been modified by later collapse^[9].

saturated flow. Single-phase flow when all voids are filled^[16]. Not to be confused with chemical saturation.

saturated water. Water that is in chemical equilibrium with its enclosing media and is thus nonaggressive. Water, at about 25°C, in contact with calcite and the normal atmosphere, will contain approximately 30 to 50 ppm of Ca when saturated, variations being due mainly to differing pH. Determination of the saturation point of natural waters is complex^[20]. Synonyms: (French.) *eau saturée*; (German.) *gesättigtes Wasser*; (Greek.) *koresménon ýdor*; (Italian.) *acqua satura*; (Spanish.) *agua saturada*; (Turkish.) *doýgun su*; (Yugoslavian.) *zasićena voda*.

saturated zone. See *phreatic zone* and *zone of saturation*.

saturation regime. A flow regime in completely saturated porous medium^[16].

saturation, zone of. See *phreatic zone* and *zone of saturation*.

scale. 1. A very thin and flat rock fragment^[16].
2. The accumulation of precipitated solid material. 3. The ratio of prototype to model dimensions.

scaling chip. A thin, small, rather irregular piece of limestone, commonly crumbly, that has fallen from the ceiling or wall of a cave. A form of cave breakdown^[10].

scaling factor. The ratio of characteristics of a model to those of the prototype^[16].

scaling plate. A small flat piece of rock of rectangular or polygonal shape that has fallen to the floor of a cave. A form of cave breakdown in thin-bedded impure limestone cut by closely spaced joints^[10].

scallop. 1. A spoon-shaped hollow carved in a cave wall, floor, or ceiling through erosion by eddies in flowing water. Scallops are commonly closely packed, leaving sharp ridges at the intersects. They range from 10 mm to 1 m in length, and as a general rule the smaller they are the faster flowing was the water that carved them. The scallops are generally asymmetrical, with their upstream end steeper than the downstream end — a useful indicator of paleo-flow direction in abandoned passages^[9]. 2. Oval hollow having an asymmetric cross-section along its main axis. Scallops form patterns on the walls of caves and in streambeds and may be used to determine direction of flow of turbulent water, since they are steeper on the upstream side. Commonly called “flutes” in America^[10]. Synonyms: (French.) *cannelure*, *vague d'érosion*; (German.) *in Fließrichtung des Wassers ausgezogener Kolk*; (Greek.) *kílon o-oithés*; (Spanish.)

huella de corriente; (Turkish.) *değirmi, tarak*. See also *flute*.

scar. (Northern England.) Steep rock cliff in limestone country often indicating outcrop of relatively bare and massively bedded limestone^[20]. Synonyms: (French.) *cicatrice, griffure*; (German.) *Klippe*; (Greek.) *oulí*; (Spanish.) *ceja* (in central Spain); (Turkish.) *kireçtaşı dik yarı*.

Schichtfugenkarren. (German.) See *bedding grike*.

scholzite. A cave mineral — $\text{CaZn}_2(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$ ^[11].

scour. The erosive action of running water in streams^[16].

screen, screen pipe. Slotted well casing that is positioned within the producing horizon to prevent the inflow of detrital particles into a well while allowing the inflow of water. See also *well screen*.

sea cave. 1. A cave cut in any rock type where a geological weakness is exploited by the highly selective erosion power of wave action. Fingal's Cave, cut in the basalt of Staffa, Scotland, is a famous example. True sea caves should not be confused with dissolutional caves that pre-dated the wave action but were then intersected and revealed as a cliff line was eroded back, such as caves in the Chalk at Beachy Head in southeast England. In some young tropical islands, dissolutional voids have formed below sea level in the mixing zone between fresh and saline ground water. Some have subsequently been tectonically uplifted into a shoreline position, to give the misleading impression of having developed

due to wave action. Caves of this type on the coast of Tongatapu, Tonga, have pools that connect with active dissolutional cavities below sea level that might be related to the mixing zone^[9]. 2. A cave or cleft in a sea cliff or coastal karst outcrop eroded by waves or currents or dissolved by circulating ground water^[20]. Synonyms: (French.) *grotte marine*; (German.) *Küstenhöhle, Meereshöhle*; (Greek.) *thalassion spelson - paraktion speleon*; (Italian.) *grotta marina*; (Russian.) *morskaja pescera*; (Spanish.) *cueva marina*; (Turkish.) *deniz mağarası*; (Yugoslavian.) *morska pećina* (spilja). See *cave*. Compare *nip*. See also *littoral zone*.

sea estavelle. Submarine or seashore opening in karst formations that at one season or period discharges round water (fresh or brackish) from the aquifer into the seabed and at another season or period draws sea water into the aquifer by a vacuum^[20]. Synonyms: (French.) *estavelle marine*; (German.) *submarine Estavelle*; (Greek.) *estavelle thalassia* (estavella); (Italian.) *Estavella sottomarina, sorgente sottomarina a flusso alterno*; (Spanish.) *estavela marina*; (Turkish.) *sahil batar çıkarı*.

sea level. The average height of the surface of the sea, used as a datum for elevations^[16].

sealing-grout, grout. Cement grout injected between a well casing and the borehole wall (annular space) to seal off an aquifer from external contamination.

sea-mill. A mill whose motive power is derived from the flow of water into (or possibly out of) a sea estavelle; the classical example is on the Vinaria Peninsulas, at

Argostolion, Kephallinia^[20]. Synonyms: (French.) *moulin de la mer*, *moulin d'Argostoli*; (German.) *Meermühle*; (Greek.) *thalassomylos*; (Spanish.) *molino de mar*; (Turkish.) *deniz suyu deđirmeni*; (Yugoslavian.) *morska vodenica*. See *sea estavelle*.

sea ponor. A submarine opening in karst formations where seawater flows or is drawn by a vacuum into the aquifer^[20]. Synonyms: (French.) *perte sous-marine*; (German.) *submariner Ponor*; (Greek.) *ypothalassia katavothra*; (Italian.) *inghiottitoio sottomarino*; (Spanish.) *sumidero marino*; (Turkish.) *denizalte suyutam*; (Yugoslavian.) *morska vodenica*, *morski ponor*. See *ponor*.

sea water intrusion. See *saltwater intrusion*.

secondary interstices. Voids formed in a rock after the rock had been formed^[16].

secondary porosity. Porosity created after rock formation through fracturing, leaching, etc.

sedimentation. The deposition of solid disintegrated rock material by water, wind, or gravity transport^[16].

sediment transport. The transport of eroded rock material by moving water or wind^[16].

seep. 1. An area, generally small, where water or oil percolates slowly to the land surface. See *seepage* and *spring*^[22]. 2. To move slowly through small openings of a porous material^[22].

seepage. 1. The infiltration or percolation of water through rock or soil to or from the

surface and usually restricted to the very slow movement of ground water. 2. The fluid discharged at a seep^[22]. 3. The amount of fluid discharged at a seep^[22]. 4. The slow flow of water through a porous medium. 5. The movement of water in unsaturated soil^[16].

seepage face. A boundary between the saturated flow field and the atmosphere along which ground water discharges, either by evaporation or movement "downhill" along the land surface or in a well as a thin film in response to the force of gravity^[22].

seepage force. The frictional drag of water flowing through voids or interstices in rock, causing an increase in the intergranular pressure (i.e., the hydraulic force per unit volume of rock or soil that results from the flow of water and that acts in the direction of flow).

seepage line. 1. The uppermost level at which flowing water emerges along a seepage face^[22]. 2. The upper free water surface of the zone of seepage. Synonymous with *line of seepage*, *phreatic line*^[22].

seepage path. The trajectory of fluid particles in seepage flow^[16].

seepage rate. The rate of seepage flow^[16].

seepage spring; filtration spring. See *spring*, *seepage*.

seepage surface. The outflow surface between water level and the intersection of the phreatic surface in a well^[16].

seepage velocity. See *specific discharge*.

selenite. Bladelike crystals of gypsum^[9].

self-cleaning capacity. The capacity of a river to clean its water of pollutants over a given length of water course^[16].

selenite needles. A sulfate speleothem having the shape of a needle that grows from gypsiferous cave soils^[13]. See also *speleothem*.

semiconfined aquifer. See *leaky aquifer*.

sepiolite. A cave mineral — $Mg_4Si_6O_{15}(OH)_2 \cdot 6H_2O$ ^[11].

series. A subdivision of rock according to age at which they were laid down in a geologic epoch^[16].

setting of cement. The process of hardening of cement^[16].

settling basin. A basin used for the settling out of solids from suspension^[16].

settling velocity. The terminal velocity at which a particle will fall through a fluid^[16].

sewage. Domestic and municipal wastes^[16].

shaft. 1. Vertical, or steeply inclined, sections of a cave passage, of enormously varied size. The world's deepest known shaft is the entrance shaft of Brezno pod Velbom on the Kanin plateau, Slovenia; it is 501 m deep, with no ledges. Much debate surrounds statistics on the depths of fully underground shafts, which may be broken by ledges, but among the deepest is a shaft about 430 m deep in Italy's Abisso di Monte Novegno^[9]. 2. A cylindrical tube, generally steep sided, that forms by solution

and (or) collapse^[10]. 3. A vertical passage in a cave^[10]. 4. A vertical and usually large diameter hole penetrating geologic formations for access of subsurface points^[16]. See *jama*, *karst shaft*. See also *pit*; *pothole* (definition 2).

shake; shakehole. (England; sometimes spelled shackhole.) 1. Term used mainly by cavers to indicate a doline, especially one formed by subsidence. 2. Hole formed by solution, subsidence, and compaction in loose drift or alluvium overlying beds of limestone^[10]. 3. Small subsidence or suffosion doline formed in the glacial till overlying limestones in the northern Pennines. See *jama*.

shall sand. Sand containing considerable amounts of clay and shale^[16].

shawl. Simple triangular-shaped curtain^[10].

shear plane. A plane along which failure of material occurs by shearing.

shear stress. See *stress*, *shear*.

sheet. A thin coating of calcium carbonate formed on walls, shelves, benches, and terraces by trickling water^[10].

sheet erosion. Erosion occurring over widespread tabular sedimentary or effusive rock^[16].

sheet jointing. Fracturing of tensile character, mostly in granitoid rocks, parallel to the land surface. Sheet jointing is developed either by load release or temperature differences.

shield; cave shield. 1. A thin circular disc of calcite projecting from a cave wall at any upward inclination, commonly a meter or more in diameter and with the underside draped with stalactites and curtains. The shield is actually a double disc with a thin central crack that acts as the continuation of a wallrock fracture. It grows by water moving up the crack under pressure and depositing calcite on both sides of its outer rim. Shields are rare, but Lehman Cave, Nevada, has more than a hundred of them^[9]. 2. A disk-shaped speleothem standing edgewise at a high angle^[10]. 3. A geologically stable and undisturbed continental block^[16].

shilin. A type of pinnacle karst formed on low plateau of gently dipping limestone; it is distinguished by densely packed pinnacles up to 25m high, fluted by sharp Rillenkarrren. Known only in southern China, shilin (pronounced sherlin) translates as “stone forest”^[9].

shore. The zone of separation between land and moving water^[16].

sieve analysis. The determination of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes^[6].

sieve opening. The opening between the mesh wires of a sieve^[16].

sieve retention. The material retained on a sieve^[16].

silicate rock. Rock containing silica in predominant proportions^[16].

silicic acid. H_4SiO_4 monomeric acid^[16].

silicon dioxide. Silica (SiO_2 .) See also *quartz*.

Silikatkarren. (German.) Granites and related rocks that possess small outcrop sculpturing such as rounded runnels. They are best developed in the humid tropics such as Malaysia^[8].

silt. A grain particle with a diameter that ranges between 0.005 to 0.05 mm^[16].

silting. The deposition of silt in wells, caves, or reservoirs^[16].

sima. (Spanish.) Natural well that has vertical sides^[10].

similarity criteria. The conditions indicating under what circumstances a model and prototype are similar^[16].

simple hydrograph. A single-peaked hydrograph^[16].

single outlet. A stream cutting through a divide (tributary basin) or outflow to the sea (major basin)^[16].

sink; sinkhole. (American.) 1. A point where a stream or river disappears underground. The sinking water may filter through a choke that excludes cavers, or may flow into an open horizontal cave or vertical shaft, and while active all of these may be termed sinkholes. The flow of water may be very small, but in full flood many sinkholes swallow flows of tens of cubic meters per second. The character of sink water (or swallet water, as it is commonly termed by hydrologists), flowing directly and rapidly into an open cave, distinguishes

it from percolation water^[9]. 2. General terms for closed depressions. They may be basin, funnel, or cylindrical shaped^[10]. See also *closed depression*; *doline*; *ponor*; *stream sink*; *sumidero*; *swallet*; *swallow hole*.

sinkhole plain. (American.) Plain on which most of the local relief is due to closed depressions and nearly all drainage is subterranean^[10].

sinkhole pond. (American.) Small lake in closed depression in limestone, due to an impervious clay floor or to intersection of depression with the water table^[10]. See *doline lake*.

sinking river, sinking stream. A small stream that disappears underground^[10]. See also *lost river*; *doline*; *ponor*; *sink*; *sinkhole*; *stream sink*; *sumidero*; *swallet*; *swallow hole*.

sinter. 1. A rock or deposit formed by precipitation from natural water, often from a hot or cold spring. Calcareous sinter is calcium carbonate and is also known as tufa, travertine, and onyx marble. Siliceous sinter is silica and is also known as geyserite and fiorite^[20]. 2. A mineral precipitate deposited by a mineral spring, either hot or cold. Siliceous sinter, consisting of silica, may be called geyserite and fluorite; calcareous sinter, consisting of calcium carbonate, may be called tufa, travertine, and onyx marble^[10]. Synonyms: (French.) *concrétion*; (German.) *Sinter*, *Kalktuff*, *Travertin*; (Greek.) *asvestolithikos toffos*; (Italian.) *concrezione*; (Russian.) *otlozenija istocnikov*; (Spanish.) *concreción*; (Turkish.) *kaynak tüfii*; (Yugoslavian.)

travertin, *sedra*, *bigar*, *lehnjak*. Related to *travertine*.

siphon. 1. Synonym for a sump, or a section of flooded cave passage, in common parlance. True siphons, where water flows first up and then down, are rare in caves, as the fractures in limestone tend to disrupt the required hydraulics. They are, however, the origin of such intermittent springs as the Fontestorbes spring in France and the Ebbing and Flowing Well at Giggleswick, Yorkshire. Both flow in regular pulses when the siphon is full and working, only to cease when the siphon input is broken by air, as the upstream reservoir level drops. Their operation depends on critical flows, and both operate only in favorable weather conditions^[9]. 2. Gallery in form of an inverted U with water moving only under pressure when the siphon has completely filled up; the water head at the input end being higher than at the drainage point^[20]. 3. In speleology, a cave passage in which the ceiling dips below a water surface^[10]. Synonyms: (French.) *siphon*; (German.) *Siphon*; (Greek.) *siphon*; (Italian.) *sifone*; (Russian.) *sifon*; (Spanish.) *sifon*; (Turkish.) *sifon*; (Yugoslavian.) *sifon*, *smrk*. See also *water trap*.

site characterization. Means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters relevant to a particular site. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing at depth needed to determine the suitability of the site for a geologic repository, but does not include

preliminary borings and geophysical testing needed to decide whether site characterization should be undertaken^[22].

skin effect. The effect of the zone of reduced permeability immediately around the borehole on transient flow phenomena in pumping tests^[16].

skrytyĭ karst, zakrytyĭ karst. (Russian.) See *closed karst*.

skylight. A hole in the roof of a cave passage through to the ground surface. It may be an inlet shaft, a section of collapse, or a breach due to surface lowering^[9].

slickenside. 1. A polished, commonly striated rock surface within a fault plane, produced by friction during fault movement. The striae give an indication of the fault movement direction^[9]. 2. A polished fault plane with grooves from relative motion of fault blocks^[16].

sliding. 1. The relative displacement of two bodies along a surface, without loss of contact between the bodies. 2. The downslope movement of rock and earth material^[16].

slocker. Local term used in the eastern Mendip Hills, England, for a swallet or stream sink^[9].

slope. The inclination of a surface^[16].

slump pit. A hollow in the clay fill of a cave floor caused by erosion beneath the fill^[10].

smithsonite. A cave mineral — $ZnCO_3$ ^[11].

snow. Solid crystalline form of water^[16].

snow cover; snowpack. The accumulated height of snow covering a given area^[16].

snow line. A line connecting elevations above which snowpack remains throughout the year^[16].

snow sampler. A tube used for the taking of cylindrical snow samples through a snow profile^[16].

snowdrift. Snow accumulation due to wind transport^[16].

sod. Root system in a soil^[16].

soda straw. 1. Proto-stalactite in which water flows down through the center of the straw. Upon entering a vadose cave passage, the change in the partial pressure of carbon dioxide causes CO_2 degassing and the slow precipitation of $CaCO_3$. The straw grows downwards as a result; water also flows down the outside of the straw, causing the stalactite to grow outwards around the straw. 2. American name for *straw stalactite*^[9].

soddy karst. See *subsoil karst*.

sodium. A naturally occurring element (Na).

soil aggregate. Loosely cemented cluster of soil particles^[16].

soil air. The air that fills soil and rock interstices above the zone of saturation^[10].

soil bulk density. The mass of dry soil per unit bulk soil^[22].

soilcover. A layer of soil material covering bedrock^[16].

soil-covered karst. See *subsoil karst*.

soil mechanics. The science of dealing with the mechanical properties of soils^[16].

soil moisture. Subsurface liquid water in the unsaturated zone, expressed as a fraction of the total porous medium volume occupied by water. It is less than or equal to the porosity^[22].

soil-moisture meter. A device used to record soil moisture in situ^[16].

soil-moisture suction. The negative pore pressure exerted by capillary forces^[16].

soil profile. A vertical section of the soil mantle, usually with distinguishable soil horizons^[16].

soil sample. A sample of soil on which soil properties are to be determined^[16].

soil swelling. The volume increase of soil due to swelling of unsaturated clay particles when in contact with water^[16].

soil water. See *soil moisture*.

soil-water pressure. The pressure (positive or negative), in relation to the external gas pressure on the soil water, to which a solution identical in composition with the soil water must be subjected in order to be in equilibrium through a porous permeable wall with the soil water^[22].

soilwater zone. The upper portion of the zone of aeration containing soil water^[16].

solid matrix. An assembly of interconnected solid mineral grains surrounded by voids^[16].

solid volume. The volume of solid particles in a porous sample^[16].

solifluction. The slow flowage of mud streams in arctic regions.

solubility. The total amount of solute species that will remain indefinitely in a solution maintained at constant temperature and pressure in contact with the solid crystals from which the solutes were derived^[22].

solum. The top layers of a soil profile^[16].

solute. The substance present in a solution in the smaller amount. For convenience, water is generally considered the solvent even in “concentrated” solutions with water molecules in the minority^[22].

solute transport. The net flux of solute through a hydrogeologic unit controlled by the flow of subsurface water and transport mechanisms^[22].

solution. 1. Synonym for dissolution, except that the product of the solution (or dissolution) process is also termed a solution, this being a combination of liquid and nonliquid (solid or gaseous) components that exists as a liquid^[9]. 2. A homogeneous mixture of two or more components. In ideal solutions, the movement of molecules in charged species are independent of each other; in aqueous solutions charged species interact even at very low concentrations, decreasing the activity of the solutes^[22]. 4. The change of matter from a solid or gaseous state to a liquid state by combination with a liquid^[10]. 5. The result of such change; a liquid combination of a liquid and a nonliquid substance^[10]. See *corrosion*.

solution breccia. A mass of rock composed of angular to rounded fragments of rock that have accumulated by solution of surrounding or underlying carbonate. See also *collapse breccia*.

solution flutes. See *rillenkarren*.

solution lake. A lake whose origin is attributed largely to solution of underlying rock.

solution notch. These form wherever humic soil borders on a very steep or vertical limestone surface. The rock becomes undercut by water rich in biogenic CO₂. In the cone karst of the humid tropics, foot caves occur, which are oversized enlargements of solution notches^[3].

solution pan. Shallow solution basin or closed depression formed on bare limestone, generally characterized by flat bottom and overhanging sides^[10]. The initial form is a closed hollow created by a humus patch. It may have overhanging side walls and a flat floor covered by algae and small pieces of broken rock. Diameters are rarely greater than 15 cm^[3]. Synonyms: (German.) *Kamenitza* or *Kamenica*, *opferkessel*; (British.) *panhole*; (Spanish.) *tinajita*. See *Kamenica*.

solution pipe. A vertical cylindrical hole attributable to solution, often without surface expression, filled with debris, such as sand, clay, rock chips, and bones^[10]. Synonym: *sand pipe*. See also *geologic organ*.

solution runnel. See *Rinnenkarren*.

solution scarp. Escarpment formed by more active solution of lower area or by corrosional undercutting of the base of the escarpment^[10].

solution subsidence. 1. Any subsidence due to solution of underlying rock, but particularly the subsidence of parts of a formation into hollows or pockets of an immediately underlying soluble formation^[10]. 2. A craterlike doline in rock other than karst limestone, formed by surface subsidence above solutionally enlarged fissures in a subsurface karst limestone stratum^[19]. Synonyms: (French.) *affaissement par dissolution*; (German.) *Lösungstaschen, Lösungstrichter*; (Greek.) *katakáthisma thiá thialíseos*; (Italian.) *subsidenza per dissoluzione, subsidenza per suberosione*; (Russian.) *prosedanie vsledstvie rastvorenija*; (Spanish.) *subsidencia por disolucion*; (Turkish.) *erime alçalmı*; (Yugoslavian.) *korozivno urūšavanje*.

sorption. 1. A general term used to encompass the process of absorption and adsorption^[22]. 2. All processes that remove solutes from the fluid phase and concentrate them on the solid phase of the medium^[22].

sótano. (Spanish for cellar or basement.) Term used in Mexico for deep vertical shafts in limestone, which may or may not lead to a cave^[10].

spangolite. A cave mineral — $\text{Cu}_6\text{Al}(\text{SO}_4)(\text{OH})_{12}\cdot 3\text{H}_2\text{O}$ ^[11].

specific capacity. The rate of discharge of water from a well per unit of drawdown. It is commonly expressed as gpm/ft or

m³/day/m and varies with pumping test duration^[6].

specific conductance. A measure of the ability of water to conduct an electrical current expressed in micromhos per centimeter at 25 °C^[22].

specific discharge. The rate of discharge of ground water per unit area of a porous medium measured at right angle to the direction of flow. Synonyms: *Darcy velocity*; *seepage velocity*.

specific drawdown. The amount of drawdown per unit discharge in a well^[16].

specific gravity. The weight of a particular volume of water that a given body of rock or soil will hold against the pull of gravity to the volume of the body itself. It is usually expressed as a percentage^[6].

specific retention, water retaining capacity. The ratio of the volume of water that a given body of rock or soil will hold against the pull of gravity to the volume of the body itself. It is usually expressed as a percentage^[6].

specific storage. The volume of water released from or taken into storage per unit volume of the porous medium per unit change in head^[6].

specific surface. The ratio of grain particle surface to the volume of grain particles^[16].

specific yield. The ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass. This ratio is stated as a percentage^[6].

spelean. Of, pertaining to, or related to caves^[10].

speleogen. A secondary cave structure formed by dissolving, such as a dome pit or a scallop^[10].

speleogenesis. Although the term literally means the birth, origin, or mode of formation of caves, the full extent of speleogenesis includes all the changes that take place between the inception and the eventual destruction of an underground drainage system. It includes development phases during which the active drainage voids are too small to be considered caves as normally defined, as well as phases when the cave no longer functions as a drain, is enlarging only by collapse and, eventually, is being totally removed^[9].

speleogenetics. The totality of all processes that affect the creation and development of natural underground cavities. These comprise corrosion, erosion, and incision, but are also influenced by lithology, tectonics, and climate.

speleologist. 1. A scientist engaged in the study and exploration of caves, their environment, and their biota^[10]. 2. Explorer of caves, caverns, and other underground openings, especially in karst. “Caver” and “potholer” are slang terms^[20]. Synonyms: (French.) *spéléologue*; (German.) Höhlenforscher, Speläologe; (Greek.) *speleologos*; (Italian.) *speleologo*; (Russian.) *speleolog*; (Spanish.) *espeleólogo*; (Turkish.) *speleolo*, *mağarabilimci*; (Yugoslavian.) *speleolog*, *spiljar*, *jamar*.

speleology. 1. Scientific study of caves, including aspects of sciences, such as geomorphology, geology, hydrology, chemistry, and biology, and also the many techniques of cave exploration^[9]. 2. The scientific study, exploration, and description of caves, cave organisms, and related features^[10]. 3. The branch of knowledge dealing with the study and exploration of underground caves^[20]. 4. Study, exploration, and description of caves, caverns, and other underground cavities in karst and, rarely, in lavas or ice^[20]. Synonyms: (French.) *spéléologie*; (German.) *Höhlenforschung, Höhlenkunde*; (Greek.) *speleologia*; (Italian.) *speleologia*; (Russian.) *speleologija*; (Spanish.) *espeleología*; (Turkish.) *speleoloji, mağarabilim*; (Yugoslavian.) *speleologija, pećinarstvo, jamarstvo*.

speleothem. 1. General term for all cave mineral deposits, embracing all stalactites, flowstone, flowers, etc. Most are formed of calcite, whose precipitation processes, related mainly to carbon dioxide levels in the water, are the direct reverse of the dissolution of limestone. Climatic influences on dissolution processes ensure that speleothems are generally larger and more abundant in the caves of the wet tropics, which are typified by thick stalactites and massive stalagmites, in contrast to the straws and flowstones of alpine caves^[9]. 2. General term for stalactites, stalagmites, moonmilk, helictites, and other secondary mineral deposits in caves and caverns^[20]. 3. A secondary mineral deposit formed in caves, such as stalactite or stalagmite^[10]. Synonyms: (French.) *concrétions cavernicoles*; (German.) *Höhlenformation*; (Greek.) *speleolithoma*; (Italian.)

concrezione; (Russian.) *natecnia obrazovanija*; (Spanish.) *concreción (estalagmítica o estalactítica)*; (Turkish.) *magara oluşuğu*; (Yugoslavian.) *sige*. See also *cave formation*.

spelunker. See *caver*.

spelunking. See *caving*.

spencerite. A cave mineral — $Zn_4(PO_4)_2(OH)_2 \cdot 3H_2O$ ^[11].

sphalerite. A cave mineral — ZnS ^[11].

spillway. A device that allows for the escape of excess water^[16].

Spitzkarren. (German.) These are isolated projections that may be of a beehive form or may be sharply pointed and tend to lie between grikes and the strike ribs of bedding grikes^[8]. See also *grike*; *bedding grike*; *clint*.

Spitzkegelkarst. (German.) Tropical karst topography containing sharply pointed residual limestone hills^[10].

splash cup. The shallow concavity in the top of a stalagmite^[10].

spongework. 1. Randomly shaped cavities created by undirected phreatic dissolution in a massive, essentially homogeneous limestone. Fine examples occur in Carlsbad Caverns, New Mexico^[9]. 2. An arrangement of partitioned depressions found in cave ceilings and walls, and attributed to the differential solution of submerged karst limestones. Larger and more isolated hollows are known as “pockets”^[19].

spongework cave pattern. A complex maze cave pattern consisting of irregular interconnecting cavities with intricate perforation of the rock. The cavities may be large or small. All spongework patterns are nonbranching in development and contain profuse travertine. In map view, these caves often appear as an irregular inkblot.

spontaneous potential. See *self-potential*.

spore tracer. Dye spores of the fern *Lycopodium clavatum*, used to label ground water in karstic terranes. Synonyms: (French.) *traceur marqueur*; (German.) *Sporenmarkierung*; (Greek.) *lycopodium ichnithetis*; (Italian.) *tracciante vegetale*; (Spanish.) *trazador de esporas*; (Turkish.) *spor izleyici*. See *isotope tracer*, *Lycopodium spores*.

spring. 1. Point where underground water emerges onto the surface, not exclusive to limestone, but generally larger in cavernous rocks. The image of a trickle of water springing from a hillside hardly matches that of a vast cave pouring forth a river, but both are called springs. Among the world's largest is the Dumanli spring, Turkey, with a mean flow of over 50 cubic meters per second. Springs may be exurgences or resurgences, depending upon the source of their water, and also may be vaclusian in character^[9]. 2. A natural outflow of water (or other liquid or gas) at the surface of the land or into surface water. In some usages, "spring" is restricted to the water that outflows, in other usages the word can refer to the water, the outlet, or to the locality of the outflow^[20]. 3. Any natural discharge of water from rock or soil onto the surface of the land or into a body of surface water^[10].

4. A discrete place where ground water flows naturally from a rock or the soil onto the land surface or into a body of surface water^[22]. Synonyms: (French.) *source*; (German.) *Quelle*; (Greek.) *pighi*; (Italian.) *sorgente*; (Russian.) *istocnik*; (Spanish.) *fuelle*; (Turkish.) *kynak*. See also *seep*.

spring, artesian. Water flowing under artesian pressure with the potentiometric surface above the land surface^[16].

spring, barrier. A subsurface barrier forcing water to rise to ground surface and discharge as a spring^[16].

spring, boiling. 1. An uncommon type of vaclusian spring, where the flow is large enough in a constricted site to form turbulence on the surface of the resurgence pool^[9]. 2. (Jamaican.) A variable-discharge artesian spring in which hydrostatic pressure is great enough to cause a turbulent or even fountainlike discharge^[19]. See also *blue hole*.

spring, boundary. A spring located at the boundary between a permeable formation overlying an impermeable substratum^[16].

spring, cave. A spring rising in a cave^[10].

spring, contact. A spring formed at the intersection of the land surface and a permeable water-bearing formation overlying a less permeable formation^[16].

spring, depression. A spring originating at the intersection of the land surface with the water table^[16].

spring, drowned. A spring that continues to function as a spring after it has become

submerged by rising sea or lake levels or by subsidence of the ground^[20]. Synonyms: (French.) *source sous-aquatique*, *source noyé*; (German.) *submarine Quelle*, *sublacustre Quelle*; (Greek.) *vethisthesa pigi*; (Italian.) *sorgente sommersa*; (Russian.) *subakvaljnij istočnik*; (Spanish.) *fuelle subacuática*; (Turkish.) *batık kaynak*; (Yugoslavian.) *potopljen izvor*, *potopljeno vrelo*, *potopljen izvir (vrelec)*. Related to *spring*, *sublacustrine*, *spring*, *submarine*.

spring, ebb-and-flow; ebbing-and-flowing well. A spring (flowing well or borehole) exhibiting periodic variation in volume of flow; this variation, which may be regular or irregular, is often attributed in karst regions to siphonic action. Ebb-and-flow springs differ from intermittent springs because the latter can be related to seasonal variations in rainfall^[20]. Synonyms: (French.) *source intermittente*; (German.) *intermittierende Quelle*; (Greek.) *pighí ambótidós kai palírrias*; (Italian.) *sorgente carsica intermittente*; (Russian.) *sifonnij istocnik*; (Spanish.) *manatial intermittente*, *fuelle intermittente*; (Turkish.) *soğultkan kaynak*; (Yugoslavian.) *periodicni ixvor*, *periodični izvir*. See also *spring*, *periodic*. Related to *intermittent spring*.

spring, drowned. A spring that continues to function as a spring after it has been submerged by rising sea or lake levels or by subsidence of the ground^[20]. Synonyms: (French.) *source sous-aquatique*, *source noyé*; (German.) *submarine Quelle*, *sublacustre Quelle*; (Greek.) *vethisthesa pigi*; (Italian.) *sorgente sommersa*; (Russian.) *subakvaljnij istočnik*; (Spanish.) *fuelle subacuática*; (Turkish.) *batık kaynak*; (Yugoslavian.) *potopljen izvor*,

potopljeno vrelo, *potopljen izvir (vrelec)*. Related to *sublacustrine spring*, *submarine spring*.

spring, fracture. A spring with its outflow openings consisting of fractures^[16].

spring, fullflow. A spring that is the sole drain of an area.

spring, gravity. A spring flowing as a result of gravity^[16].

spring head alcove. The arcuate cliff surrounding many risings, formed by progressive headward sapping and cavern collapse. The rapidity of their formation is increased by the cliff-line, which frequently exists already at the lower margin of the karst area^[19].

spring, intermittent. 1. A karst spring with a pulsating flow, caused by the presence within the rock of cavities and siphons fed by a subterranean watercourse. When the cavity is full, the siphon is complete and causes a pulse of water to issue from the spring. This diminishes or empties the water supply in the cavity, and no further water is discharged from the spring until the system is reactivated. The discharge is said to be a *reciprocating* spring when a reduced level of flow is maintained between pulses^[19]. 2. A spring flowing at irregular intervals^[16]. Synonyms: (French.) *source temporaire*, *source intermittente*; (German.) *intermittierende Quelle*, *periodische Quelle*; (Greek.) *thialepousa pege*; (Italian.) *sorgente temporanea*, *sorgente intermittente*; (Russian.) *peremezajuscijisja istočnik*; (Spanish.) *fuelle intermitente*, *fuelle temporal*; (Turkish.) *kesintili kaynak*; (Yugoslavian.) *periodicko vrelo*,

potajnica, obdobni izvir. Related to *spring*, *ebb-and-flow*; *spring*, *periodic*.

spring, karst. A spring emerging from karstified limestone^[10]. See also *emergence*; *exurgence*; *resurgence*; *rise*.

spring, medicinal. A spring with healing properties^[16].

spring, mineral. A spring having a high mineral content.

spring, overflow. A spring that is part of a distributary but that drains only at the level above base flow.

spring, perched karst. The emergence of underground water somewhere above the basement of a calcareous massif caused by the interbedding of an impermeable or intermittent *perched water table* by restricting the vertical movement of water, which instead issues from the contact^[19].

spring, perennial. Stream flowing above land surface throughout the year^[16].

spring, periodic. A spring that shows variation in flow that is either regular or irregular. It may be due to siphonic action^[20]. Synonyms: (French.) *source périodique*; (German.) *Periodische Quelle*, *intermittierende Quelle*; (Greek.) *periodhiki piyi*; (Italian.) *sorgente periodica*; (Spanish.) *fuelle periódica*; (Turkish.) *periyodik kaynak*; (Yugoslavian.) *periodični izvor (izvir)*. See *ebb-and-flow spring*. Related to *intermittent spring*.

spring, saline. Spring water having a high salt content^[16].

spring, seepage. A spring where surface discharge occurs from numerous small openings^[16]. Synonym: *filtration spring*.

spring, subaqueous. A spring that discharges below the surface of a water body (e.g., ocean, lake, river, or stream)^[16].

spring, sublacustrine. A spring emerging in the bed of a lake predominantly in karst areas^[20]. Synonyms: (French.) *source sous lacustre*; (German.) *Unterwasserquelle*, *sublacustre Quelle*; (Greek.) *ypovrichios pighi*; (Italian.) *sorgente sublacustre*; (Russian.) *istocnik na dne ozera*; (Spanish.) *fuelle sublacustre*; (Turkish.) *gölaltı kaynağı*. See *spring, drowned*.

spring, submarine. 1. A spring emerging in a sea or lagoon predominantly in karst terranes. This is a descriptive term generally corresponding to the genetic term “drowned spring”^[20]. 2. Large offshore emergence, generally from cavernous limestone, but in some areas from beds of lava^[10]. Synonyms: (French.) *source sous marine*; (German.) *Untermeeresquelle*, *Grundquelle*, *submarine Quelle*; (Greek.) *ypothalassia pighi*; (Italian.) *sorgente sottomarina*; (Russian.) *submarinnij istocnik*; (Spanish.) *fuelle submarina*; (Turkish.) *denizaltı kaynağı*; (Yugoslavian.) *vrulja*. See *spring, drowned*.

spring, thermal. A spring with temperature of the spring water above the average temperature of superficial rock^[16].

spring, tubular. A spring issuing from a round channel such as a tubular passage^[16].

spring, unconformity. A spring issuing at the contact of an aquifer with an unconformity.

spring, underflow. A spring that is part of a distributary but is at lower elevation and preferentially drains base flow. Between it and an overflow spring there may be several underflow-overflow springs.

spring, valley. Springs occurring at valley sides where the water table intersects the land surface.

spring, vaucushman; rising, vaucushman. 1. A type of rising or spring where direct drainage from the phreatic flows up a flooded cave passage under pressure to emerge in daylight. The term is best applied where water rises from a vertical or very steep bedrock passage. Such risings are named after the Fontaine de Vaucluse in southern France. The River Sorgue rises from the Fontaine with a mean flow of 26 cubic meters per second. Its upper part is steeply inclined, but at depth it is vertical. A diver has reached a depth of 200 m, and a robot reached 243 m, below which the flooded shaft continues^[9]. 2. Large karst spring (name by Fournet, after la Sorgue en Vaucluse, France) characterized by a stream surging up as from a siphon. Also applied to karst springs with artesian characteristics^[20]. 3. A large spring or exsurgence of an underground river, generally from limestone, that varies greatly in output and is impenetrable except with diving apparatus^[10]. Synonym: (American.) *gushing spring*; (French.) *source vaucushmanne, bouillidou (South of France)*; (German.) *Vauclusequelle, (Riesenquelle)*; (Greek.) *kephalari/vaucushmaniana pighi*; (Italian.) *sorgente valchiusana*; (Russian.) *vokljuz*; (Spanish.) *fuelle vaucushmaniana, ojo, heryidero*; (Turkish.) *basınçlı kaynak*; (Yugoslavian.) *voklisko vrelo, obrh*. See also *gushing spring*.

squeeze. A narrow passage or opening just passable with effort. Differs from flattener in that there is little spare space in any direction^[10].

staff gage. A fixed graduated scale^[16].

stage. Water surface elevation at a point along a stream, river, lake, etc., above an arbitrary datum^[16].

stage-discharge relation. See *rating curve*.

stage hydrograph. The elevation of stage plotted against time^[16].

stage record. Stage discharge relations presented in tabulated form^[16].

stagnalite. A general term including stalactite and stalagmite. Superseded by *dripstone*^[10].

stagnation point. The foremost point on a streamline dividing an area of pumping depression from a zone of influence in a tilted aquifer being pumped by a well^[16].

stalactite. 1. Speleothem, generally of calcite, formed by dripping water and hanging from a cave roof. Stalactites embrace an enormous variety of sizes and shapes. They form where percolation water seeps from a cave ceiling and becomes saturated with respect to calcite because of loss of carbon dioxide into the cave air. Calcite is precipitated round the rim of the water droplet and continued deposition creates a hollow tubular straw stalactite (soda straw). Additional deposition of calcite on the outside of the initial cylinder creates an ordinary tapering stalactite. Almost infinite variation in shape may be influenced by

changes in water flow, cave air chemistry, evaporation, temperature or dissolved impurities, and by crystal growth blocking flow paths. They are the most common speleothem. Though the single 7 m long stalactite in Ireland's Poll an Ionain is not the world's longest, it is uniquely spectacular against the dark chamber walls^[9]. 2. Conical deposit of calcite or aragonite, often with a hollow center hanging from the roof of a cave or cavern formed by precipitation of carbonate due to escape of CO₂ from hanging water beads and to evaporation of part of the water^[20]. 3. A cylindrical or conical deposit of minerals, generally calcite, formed by dripping water, hanging from the roof of a cave, generally having a hollow tube at its center. From Greek word meaning "exude drops"^[10]. Synonyms: (French.) *stalactite*; (German.) *Tropfstein*, *Stalaktit*; (Greek.) *stalaktitis*; (Italian.) *stalattite*; (Russian.) *stalaktit*; (Spanish.) *estalactita*; (Turkish.) *sarkıt* (Yugoslavian.) *mosur*, *viseci kapnik*, *stalaktit*.

stalagmite. 1. Speleothem, normally of calcite, formed by upward growth from a cave floor, and therefore the complement of a stalactite. Stalagmites form when dripwater that is still saturated falls from a cave roof or stalactite and, when or after it lands, loses more carbon dioxide to the cave air, causing precipitation of calcite. They vary in size and shape, from tall thin towers to wide domes that grade into flowstone, the main controls being drip rate and height, and saturation levels of the water. The stalagmites of Aven Armand, France, are of the multiple splash-cup variety, being notably slender and up to 30 m tall. Spectacularly massive stalagmites occur in the Carlsbad and Cottonwood

Caves of New Mexico^[9]. 2. Columnar or partly irregular deposit of calcite or aragonite on the floor of a cave or cavern formed by the precipitation of carbonates due to escape of CO₂ from water dripping from the roof^[20]. 3. A deposit of calcium carbonate rising from the floor of a limestone cave, formed by precipitation from a bicarbonate solution through loss of CO₂. The water drops on the stalagmite from above. From Greek word meaning drip^[10]. Synonyms: (French.) *stalagmite*; (German.) *Bodenzapfen*, *Stalagmit*; (Greek.) *stalagmitis*; (Italian.) *stalagmite*; (Russian.) *stalagmit*; (Spanish.) *estalagmita*; (Turkish.) *dikit*; (Yugoslavian.) *óulak*, *stoječi kapnik*, *stalagmit*. See also *dripstone*.

stalagmite, capillary. See *capillary stalagmite*.

standard deviation. A measure of variability of the square of individual deviations from their mean^[16].

standing line. A rope of approximately 0.4375 inches or 11 mm in diameter that is tied to a solid anchor and is used for descending and ascending^[13]. See also *ascender*; *knot*; *mechanical ascender*; *prusik knot*; *prusiking*.

state of solution. The degree to which a mineral or rock has gone into solution^[16].

static head. See *head*, *static*.

static water level. The level of water in a well that is not being affected by withdrawal of ground water^[6].

steady flow. Flow where the velocity at a point remains constant with respect to time^[16].

steam hole. An opening from a cavity through which a current of air charged with vapor blows upwards and condenses at the orifice to appear as steam. Such openings are an occasional feature in karst terranes^[20]. Synonyms: (French.) *puits à vapeur, puits fumant*; (German.) *Dampfschlot*; (Greek.) *atmotrypa*; (Spanish.) *cavidad fumante*; (Turkish.) *buhar deliği*.

steep. The property of inclination with a very steep gradient^[16].

steephead. A deeply cut valley, generally short, terminating at its upslope end in an amphitheater, at the foot of which a stream may emerge^[10].

stemflow. Rain water flowing down the stem of plants^[16].

stereo aerial photographs. Aerial photographs shot in sequence over a landscape so that when adjoining photos are viewed at the proper interpupillary spacing, features may be seen in three dimensions.

stereogram. A block diagram or three-dimensional diagram^[16].

stilling well. A well connected to a flowing stream or spring through a bottom conduit permitting elevation measures to be taken in quiescent water^[16].

stomatal transpiration. The transpiration by escape of water through pores (stomata) of leaves^[16].

stone forest. See *shilin*.

stopping. The upward migration of the ceiling in a passage or room by the action of slabs falling^[13].

storage capacity. 1. The ability of an aquifer to store water^[16]. 2. The capacity of rivers to store water in their own channel^[16].

storage coefficient. 1. The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head^[22]. In a confined aquifer, the water is derived from storage, with decline in head resulting from an expansion of the water and compression of the aquifer. Similarly, water added to storage with a rise in head is accommodated partly by compression of the water and partly by expansion of the aquifer. In an unconfined aquifer, the amount of water so released or accepted is generally negligible compared to the amount involved in gravity drainage or filling of pores, hence, in an unconfined aquifer, the storage coefficient is virtually equal to the specific yield. 2. The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (virtually equal to the specific yield in an unconfined aquifer.) 3. The volume of water a confined hydrogeologic unit releases from or takes into storage per unit subsurface area of the hydrogeologic unit per unit change in head.

storage gage. A precipitation gage for collecting and storing the total amount of inflowing water to be read at long intervals^[16].

storage in depressions. Water retention in surface depressions^[16].

storativity. See *storage coefficient*.

storm. 1. A disturbance of average meteorological conditions and usually connected with precipitation^[16]. 2. A period of precipitation over a specific drainage basin^[16].

strath terrace. An erosional remnant of an elevated broad river valley^[16].

stratification. 1. A depositional structure of sedimentary rocks in beds and layers^[16]. 2. The separation into nondiscrete layers of water as a result of chemical, saline, or temperature differences which in turn create density differences in the water.

stratigraphic column. A graphic means of representing the various rock types of an area in a geologic report^[13].

stratigraphic sequence. The sequence of rock types in an area^[13].

stratum. A sedimentary bed or layer^[16].

straw stalactite; straw. 1. The simplest form of stalactite — a fragile, thin-walled tube, normally of calcite, which is the diameter of the drops of water that hang from its end and continue its growth. Though only about 5 mm in diameter, straw stalactites (or straws) may grow to great length in clusters of spectacularly dense profusion, more commonly in caves of cooler climates. The length record may be held by a 6 m straw in Easter Cave, Western Australia. Also known as “straw stalactite” or “soda straw”^[9]. 2. Thin tubular stalactite,

generally less than a centimeter in diameter and of very great length (examples as long as 4 meters); also called soda straw^[10]. See also *soda straw*; *stalactite*.

stream. A body of flowing water^[16].

stream bed. The bottom of a stream covered by water^[16].

stream development. The ratio of actual tortuous stream length between two points on a straight line connecting these points^[16].

stream flow. The total runoff confined in a stream and its channel^[16].

stream frequency. Channel frequency; the number of stream segments per unit area^[16].

stream order. The hierarchic order of stream segments according to tributaries^[16].

stream profile. The elevation of the main stream bed as a function of distance from outflow.

stream sink. Point at which a surface stream sinks into the ground^[10]. See also *doline*; *ponor*; *sink*; *sinkhole*; *sumidero*; *swallet*; *swallow hole*.

streamtube. 1. A cave passage completely filled, now or in the past, with fast-moving water and whose ceiling and walls normally show scallops^[10]. 2. The imaginary space formed between two adjacent streamlines in which flow is constant (assuming steady flow conditions). Synonyms: (French.) *conduite forcée*; (German.) *Druckflußrohr*; (Greek.) *ypóghios síranx*; (Italian.) *condotta forzata*; (Spanish.) *tubo (o*

conducto) fréatico; (Turkish.) akarsu mecrası. See conduit, pressure flow tube.

streamline. A curve that is everywhere tangent to the specific discharge vector and indicates the direction of flow at every point in a flow domain.

strength. The maximum stress that a material can resist without failing for any given type of loading.

stress. The force acting across a given surface element divided by the area of the element.

stress, applied. The downward stress imposed at an aquifer boundary. It differs from effective stress in that it defines only the external stress tending to compact a deposit rather than the grain-to-grain stress at any depth within a compacting deposit^[21].

stress, effective. Stress (pressure) that is borne by and transmitted through the grain-to-grain contacts of a deposit, and thus affects its porosity or void ratio and other physical properties. In one-dimensional compression, effective stress is the average grain-to-grain load per unit area in a plane normal to the applied stress. At any given depth, the effective stress is the weight (per unit area) of sediments and moisture above the water table, plus the submerged weight (per unit area) of sediments between the water table and the specified depth, plus or minus the seepage stress (hydrodynamic drag) produced by downward or upward components, respectively, of water movement through the saturated sediments above the specified depth. Thus, effective stress may be regarded as the algebraic sum of the two body stresses, gravitational stress and seepage stress. Effective stress

may also be regarded as the difference between geostatic and neutral stress^[21].

stress, geostatic. The total load per unit area of sediments and water above some plane of reference. It is the sum of the effective stress and the neutral stress^[21].

stress, neutral. Fluid pressure exerted equally in all directions at a point in a saturated deposit by the head of water. Neutral pressure is transmitted to the base of the deposit through the pore water, and does not have a measurable influence on the void ratio or on any other mechanical property of the deposits^[21].

stress, preconsolidation. The maximum antecedent effective stress to which a deposit has been subjected, and which it can withstand without undergoing additional permanent deformation. Stress changes in the range less than the preconsolidation stress produce elastic deformations of small magnitude. In fine-grained materials, stress increases beyond the preconsolidation stress produce much larger deformations that are principally inelastic (nonrecoverable)^[21].

stress, seepage. When water flows through a porous medium, force is transferred from the water to the medium by viscous friction. The force transferred to the medium is equal to the loss of hydraulic head. This force, called seepage force, is exerted in the direction of flow^[21].

stress, shear. Stress directed parallel (tangential) to the surface element across which it acts.

strike. The direction or azimuth of a horizontal line in the plane of an inclined

stratum, joint, cleavage plane, or other planar feature within a rock mass.

strike valley. A valley following the strike of underlying strata^[16].

structure. One of the larger features of a rock mass (e.g., bedding, foliation, jointing, cleavage, brecciation, etc.) Also the sum total of such features as contrasted with texture. In a broader sense, it refers to the structural features of an area such as anticlines or synclines.

structural factor. Features modifying or interrupting the continuity of rock types^[16].

structural geology. That part of geology dealing with structures formed in rocks^[16].

struga. (Slavic.) A corridor formed along a bedding plane in karst country^[10].

stylolite. An irregular suturelike boundary developed along some bedding planes in limestones, probably caused by dissolution under pressure and possibly related in some cases to subsequent inception of speleogenesis^[9].

subaqueous spring. See *spring, subaqueous*.

subaqueous karst. A karst terrane that is covered by a discrete body of water^[17]. See also *drowned karst; subfluvial karst; submarine karst*.

subartesian well. An artesian well with insufficient head to raise water above the land surface^[16].

sub-conduit. Any void, whether of tectonic or dissolutional origin, that is smaller than

the accepted defined size of a conduit. Sub-conduits originate under inception conditions and enlarge during gestation, but many fail to achieve larger dimensions when drainage later becomes concentrated along preferred routes. In most cases, however, they will continue to function as part of the microfissure, or percolation, system within the rock mass. Sub-conduits are an essential part of a continuum of void sizes that extends between microscopic discontinuities and the largest tube passages^[9].

subcutaneous drain. Discrete percolation drains contained within the epikarst zone and leading to the transition zone. See also *epikarst zone; subcutaneous flow; subcutaneous zone; transition zone*.

subcutaneous flow. Lateral and vertical flow that occurs within the epikarst zone under saturated conditions. Lateral flow distances can exceed hundreds of meters and several meters per day while vertical flow within discrete percolation drains (subcutaneous drains) may allow flow rates in excess of several hundred meters per hour. See also *epikarst zone; subcutaneous drain; subcutaneous zone; transition zone*.

subcutaneous zone. Synonym for *epikarst zone*.

subfluvial karst. Karst topography developed beneath a river. See also *subaqueous karst*.

subjacent karst. Karst landscape in noncarbonate rocks due to presence of karstified rocks beneath the surface formation^[10]. Synonyms: (French.) *karst sous-jacent*; (German.) *unterirdisches*

Karstphänomen; (Greek.) *ypokímenon karst*; (Russian.) *pokritij karst*; (Spanish.) *karst subyacente*; (Turkish.) *gizli karst*; (Yugoslavian.) *pokriven kŕš(kras)*. See also *interstratal karst*.

subkutan karst. See *subsoil karst*.

sublacustrine spring. See *spring, sublacustrine*.

sublimation. The direct conversion of water from its solid state to the vapor phase^[16].

submarine karst. Karst topography developed below the tidal zone. See also *subaqueous karst*.

submarine spring. See *spring, submarine*.

subpermafrost karst. Underground karst in areas of permafrost. Karstification is due to the solvent action of subpermafrost (or intrapermafrost) water^[20]. Synonyms: (French.) *karst sous-permafrost*; (German.) *Pseudokarst*; (Greek.) *karst ypomonímou paghetoú*; (Italian.) *carsismo di subpermafrost*; (Russian.) *podmerzlonij karst, mezmerzlotnij karst*; (Spanish.) *karst de subpermafrost, karst de intrapermafrost*; (Turkish.) *don alan yeraltı karstı*. See *permafrost karst*. See also *intrapermafrost karst*.

subpermafrost water. Ground water below the permafrost^[16].

subsequent river. 1. A river flowing along the strike of a weak formation^[16]. 2. A tributary to a consequent river^[16].

subsidence. Lowering of the surface of the ground because of removal of support.

Caused in karst areas by subterranean solution or collapse of caves^[10].

subsidence doline. A closed karst depression formed by local subsidence of the surface rocks and/or soil into cavities formed by widespread dissolution or local collapse of caves. The type of subsidence doline formed by downwashing of the soil cover is better described as a suffosion doline^[9]. Also known as *sinkhole*.

subsidence/head-decline ratio. The ratio between land subsidence and hydraulic head decline in the coarse-grained beds of the compacting aquifer system^[21].

subsoil karst. Karst covered by soil, usually residual soil^[17]. Synonyms: (British.) *soddy karst*; (French.) *karst vert, karst subcutané*; (German.) *bedeckter Karst, bodenbedeckter Karst, griükarst, subkutan karst*; (Greek.) *ypethaphikon karst*; (Russian.) *zadernovannyĭ karst*; (Spanish.) *karst subcutáneo*; (Turkish.) *toprakaltı karstı*; (Yugoslavian.) *pokriveni kŕš(kras)*. See also *covered karst*.

subsurface divide. See *underground divide*.

subsurface flow. See *subsurface runoff*.

subsurface runoff, storm seepage, subsurface flow, subsurface storm flow. Runoff due to infiltrated precipitation moving laterally under the surface.

subsurface water. All water that occurs below the land surface^[22].

subterranean. Beneath the land surface^[16].

subterranean cut-off. The diversion underground of a surface watercourse beneath a surface meander neck, marked by a swallow hole on the upstream side and a spring on the downstream side^[19]. See also *stream piracy*.

subterranean river, subterranean stream. Underground stream of flowing water in caves and caverns, but not necessarily large^[10]. See also *underground stream*.

suction. See *moisture tension*.

suffosion. Undermining through removal of sediment by mechanical and corrosional action of underground water^[20]. Synonyms: (French.) *soutirage karstique*; (German.) *Anzapfung*; (Greek.) *ypoghion thiavrosis*; (Russian.) *suffozija*; (Spanish.) *sufosión*; (Turkish.) *karstik yeraltısuyu kazıması*; (Yugoslavian.) *sufozija*.

suffosion doline. More accurate synonym for a type of subsidence doline, indicating formation by the suffosion, or downwashing, of the soil into an underlying fissure^[9]. Also known as *shakehole*.

sulfate. A mineral compound characterized by the sulfate radical SO_4^{2-} . Anhydrous sulfates, such as barite, BaSO_4 , have divalent cations linked to the sulfate radical; hydrous and basic sulfates, such as gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, contain water molecules^[1].

sulfate minerals. Minerals containing the SO_4^{2-} radical, formed by precipitation from water. The most common are the anhydrous and hydrated calcium sulfates, anhydrite (CaSO_4) and gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Sulfates are deposited as a generally minor component of most

carbonate successions, but because of their high solubility they may not survive subsequent dissolution by ground water. Even if they survive subsequent dissolution by ground water. Even if they survive at depth, they tend to dissolve as they are raised nearer to the surface following uplift and erosion of overburden. Removal of sulfates by dissolution may contribute to the early establishment of secondary permeability in limestone sequences. Sulfate solutions have a limited corrosional effect upon calcium carbonate, but may also be oxidized to produce sulphuric acid, which is highly corrosive of limestone.

sulfate-reduction karst. Karst topography developed in the subsurface where solution of bedrock is chiefly a result of sulfate reduction by petroleum hydrocarbons aided by bacterial processes that oxidize hydrocarbons to yield carbon dioxide. Little, if any, of the water that dissolves the rock is meteoric^[17].

sulfide. A mineral compound characterized by the linkage of sulfur with a metal or semimetal, such as galena, PbS , or pyrite, FeS_2 ^[1]. See also *gypsum* and *pyrite*.

sulfide minerals. Minerals that are composed of one or more metals combined with sulphur. The most common is pyrite. They are believed to be produced by the metabolic action of microorganisms and are found in many sedimentary rocks, usually in trace amounts.

sulfuric acid. An acid (H_2SO_4).

sumidero. (Spanish.) 1. A swallow hole. 2. In Latin America, any closed depression caused by solution^[10].

summation curve. A curve of cumulated values^[16].

summit. The highest point of a physiographic feature^[16].

sump. 1. In caves a sump is a section of flooded passage. This may be a perched sump, probably quite short, within a vadose cave and created by a local reverse passage gradient. Alternatively it may be a major feature, where a cave passage descends below the regional water table into the phreas, as is common at the lower end of many cave systems. Some short sumps can be dived without the use of breathing apparatus, but most are restricted to exploration by cave divers. Logistics are a barrier to endless sump penetrations, but some have now been explored for many kilometers in length, notably in Cocklebiddy Cave, Australia, the Nohoch Nah Chich and other great flooded systems in Mexico's Yucatan, and behind Keld Head in Yorkshire^[9]. 2. A pool of underground water or point on an underground stream that has a submerged extension, the nature of which has not been determined^[10]. 3. A place where the ceiling of a passage drops to and below water level in a cave, leaving no air space with the cave passage continuing underwater^[13]. 4. A water trap.

sunken pan. An evaporation pan buried in the ground for equal elevation of the water surface with the ground surface^[16].

superimposed valley. A valley established on the land surface with a pattern that is independent of the underlying rock structure.

supersaturation. A liquid that is oversaturated with respect to whatever particles may be contained in the fluid.

suprapermafrost karst. Surface karst in areas or permafrost. Karstification is due to the solvent action of suprapermafrost water^[20]. Synonyms: (French.) *karst suprapermafrost*; (German.) *Pseudokarst*; (Greek.) *karst epi monímu paghetoú*; (Italian.) *carsismo superficiale di permafrost*; (Russian.) *nadmerzlotnij karst*; (Spanish.) *karst de suprapermafrost*; (Turkish.) *don alan yüzey karstı*. See also *permafrost karst*.

suprapermafrost water. Ground water above permafrost^[16].

surf karren. Surf karren form along marine limestone and dolomite coasts where the surf sprays water onto abrasion surfaces that lie slightly above normal sea level. They are a result of corrosion caused by the mixing of sea- and rain water, but do not exist under the sea surface as sea water is not limestone-corrosive. Beyond the splashwater zone the karren are much less sharp^[3].

surfactant. A substance capable of reducing the surface tension of a liquid in which it is dissolved. Used in air-based drilling fluids to produce foam, and during well development to disaggregate clays^[6]. Surfactants are now being considered for aquifer remediation by helping disperse immiscible contaminants.

surface detention. Sheet flow of water in overland flow before a channel is reached^[16].

surface entry. An opening immediately at the land surface that permits infiltration to take place^[16].

surface film. A monomolecular film of organic compounds forming on water or grain surfaces^[16].

surface mapping. The topographic and geodetic mapping of an area^[16].

surface mine. Strip mine^[16].

surface retention. Water held on land surface^[16].

surface runoff. That part of runoff traveling over the ground surface and through channels^[16].

surface seepage. Surface discharge of ground water not important enough to form a rivulet^[16].

surface spreading. A method of artificial recharge of water to an aquifer by spreading on a surface^[16].

surface tension. The free specific surface energy occurring at the interface between a liquid and its own vapor phase^[16].

surface water. Water obtained from surface supplies^[16].

susica. Yugoslavian term for intermittent stream or river in a karst terrane in which the water diverts and soaks gradually into the karst ground-water system^[20]. See also *intermittent river*.

suspended load. Detrital matter being transported in suspension by a moving stream^[16].

suspended matter. Solid matter small enough to be held in suspension by moving or stagnant water^[16].

suspended water. See *vadose water*.

sustained yield. The rate at which water can be withdrawn from an aquifer without depleting the supply^[16].

swale. A marshy depression or depression in a ground moraine^[16].

swallet, swallow hole. (British.) A place where water disappears underground in a limestone region. A swallow hole generally implies water loss in a closed depression or blind valley, whereas a swallet may refer to water loss into alluvium at a streambed, even though there is no depression^[10]. See also *doline*; *ponor*; *sink*; *sinkhole*; *stream sink*; *sumidero*.

swelling. The volume increase due to intake and absorption of water, especially clays^[16].

swelling rate. The time rate of volume increase^[16].

synclinal valley. A valley following the axis of a syncline^[16].

syncline. Downfolded stratum^[16].

syngenetic karst. 1. Karst developed contemporaneously with the lithification of the formation, as in eolian calcarenite, where lithification and karstification of dune sands may proceed simultaneously^[10]. 2.

Karst landforms that developed upon young, porous carbonate rocks, such as aeolianites, as they underwent lithification^[9]. Synonyms: (French.) *karst syngénétique*; (German.) *Syngenetischer Karst*; (Greek.) *synegeticon karst*; (Italian.) *carsismo singenetico*; (Spanish.) *karst singenético*; (Turkish.) *eştürümlü karst*; (Yugoslavian.) *singenetski krš(kras)*.

syngenite. A cave mineral — $\text{K}_2\text{Ca}(\text{SO}_4)_2 \cdot \text{H}_2\text{O}$ ^[11].

synoptic network. A network of first-order stations permitting the regular observation of weather for all points at the same time^[16].

synthetic unit hydrograph. A unit hydrograph constructed by assuming the reaction of a drainage basin will be based on its physical characteristics^[16].

T

table mountain. A flat-topped mountain (mesa)^[16].

tailwater. The lower course of a river with respect to a given point of structure^[16].

talus cone. A conelike collection of disintegrated rock material originating from and adjacent to a steeper slope^[16].

taranakite. A cave mineral — $\text{KAl}_3(\text{PO}_4)_3(\text{OH})\cdot 9\text{H}_2\text{O}$ ^[11].

tarbuttite. A cave mineral — $\text{Zn}_2(\text{PO}_4)(\text{OH})$ ^[11].

taylorite. A cave mineral — $(\text{K},\text{NH}_4)_2\text{SO}_4$ ^[11].

tectokarst. Karst formed under the strong influence of tectonic disturbances. The term is indefinite and its use is not generally recommended^[20]. Synonyms: (French.) *tectokarst*; (German.) *Tektonischer Karst*; (Greek.) *tektonikon karst*; (Russian.) *karst zon tektoniceskih razlomov*; (Spanish.) *tectokarst*; (Turkish.) *tektonik karst*; (Yugoslavian.) *tektokrš tektokras, tektokarst*.

tectonic. Pertaining to structural features due to the deformation of the crust^[16].

tectonic cave. A cave formed by some form of ground movement. The most common is due to landsliding in a jointed rock, leaving an open fissure cave parallel to the line of the hillside along the back of the slipped block. Tectonic caves can form in any rock, as they do not depend on dissolution. Well-known examples are the windypit fissures of northeast Yorkshire, England,

some of which are hundreds of meters long and up to 60 m deep^[9].

tectonic valley. A valley formed by tectonic forces^[16].

temperature efficiency. An efficiency factor defined by Thornthwaite for different climates. See also *Thornthwaite*.

temperature log. A recording curve of ground-water temperature in a well^[16].

temporary hardness. See *carbonate hardness*.

tenorite. A cave mineral — CuO ^[11].

tensiometer. A device used to measure the moisture tension in the unsaturated zone^[22].

terminal moraine. A glacial deposit accumulated in front of a glacier^[16].

terra rossa. 1. Reddish-brown soil mantling limestone bedrock; may be residual in some places^[10]. 2. Insoluble residuum of a reddish-brown color left behind when carbonate rocks weather under Mediterranean or allied climatical conditions^[20]. Synonyms: (French.) *terra rossa*; (German.) *Kalksteinroterde*; (Greek.) *erythroghi*; (Italian.) *terra rossa*; (Russian.) *terra-rossa*; (Spanish.) *terra rossa*; (Turkish.) *kızıl toprak, terrarosa*; (Yugoslavian.) *crvenica, jerina, jerovica*.

terrace. A flat surface bounded by steplike steep slopes^[16].

terraced flowstone. Shallow rimstone pools on outward-sloping walls^[10]. See also

rimstone barrage; rimstone barrier; rimstone dam; constructive waterfall.

terrain. An area with some specific characteristics. Reserved for surficial features only. Contrast with *terrane*.

terrane. An area with some specific characteristics^[16]. Includes both surface and subsurface features. Contrast with *terrain*.

tertiary porosity. See *porosity, tertiary*.

test hole. A hole to test the depth of ground water, water quality, or geological conditions^[16].

texture. The arrangement in space of the components of a rock body and of the boundaries between these components^[16].

thalweg. A line of maximum depth of stream cross-section^[16].

Theis equation. The nonequilibrium equation of radial flow towards a well^[16].

thenardite. A cave mineral — Na_2SO_4 ^[11].

thermal spring. See *spring, thermal*.

thermal stratification. The stratification of water in reservoirs because of thermal-density differences^[16].

thermocline. An intermediate layer in stratified water^[16].

thermocouple. A temperature measuring device based on the proportionality between thermoelectric current and temperature difference between thermojunctions^[16].

thermokarst. 1. A pitted periglacial or former periglacial surface in superficial deposits, produced by settling or caving of the ground after melting of ground ice^[10]. 2. A term applied to topographic depressions in karstic terranes resulting from the thawing of ice. See *cryokarst*.

thermokarst pit. Steep-walled depression formed by thermokarst processes^[10].

thickness. The perpendicular distance between bounding surfaces such as bedding or foliation planes of a rock.

thief zone. The zone through which drilling fluid is lost into a formation through the borehole wall^[16].

Thiem equation. The equation that describes steady-state equilibrium radial flow into a well^[16].

thixotropy. The property of a gel to become fluid under application of shear stresses^[16].

threshold. That part of a cave system to which light penetrates in some degree^[10].

threshold saturation. Saturation below which no flow occurs^[16].

through cave. Cave through which a stream runs from entrance to exit or formerly did so^[10]. Synonym: (German). *Durchgangshöhle*.

throughfall. A part of precipitation that reaches ground by falling through vegetative cover^[16].

throw. The vertical displacement of stratum along a fault plane^[16].

thrust; thrust fault. A generally gently dipping or subhorizontal fault plane where the relative movement has been essentially horizontal, with one rock sequence being pushed across and above another. Some cave development in the Traligill area of northwest Scotland has been guided by thrust planes^[9].

tidal river. A river strongly influenced and subject to tidal currents^[16].

tidewell. See *spring, ebb-and-flow*.

tightest packing. An arrangement of particles allowing only minimum void space a unit cell of a sample^[16].

till. Predominantly unsorted and unstratified drift, generally unconsolidated, deposited directly by and underneath a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, and boulders ranging widely in size and shape^[6].

tilted aquifer. A dipping aquifer^[16].

time base. The sum of storm duration time and concentration time in a hydrograph^[16].

time-drawdown curve. A plot of drawdown variation with time^[16].

time lag. The time elapsed between the onset of a certain event and the reaction to this event^[16].

time of concentration. The time required for surface runoff produced in the farthest part of a basin to reach a concentration point under consideration^[16].

time of rise. The time between the first arrival of runoff and arrival of the peak flow^[16].

tinajita. (Spanish.) See *solution pan*.

tinticite. A cave mineral — $\text{Fe}_6(\text{PO}_4)_4(\text{OH})_6 \cdot 7\text{H}_2\text{O}$ ^[11].

toadstone. Local term in the Peak District, England, for lavas, tuffs, and igneous intrusions within the local Carboniferous carbonate sequence.

topographic divide. A crest line dividing one drainage basin from another^[16]. See also *divide*.

topographic map. A map representing the land surface via the use of contour lines, which are lines of equal elevation on the earth's surface. Synonym: topo map.

topography. The physical features of a geographical area^[16].

topsoil. The topmost portion of a soil profile^[16].

torca. (Spanish.) Large closed depression, more or less circular; a doline^[10].

torricellian chamber. A submerged air-filled chamber of a cave at a pressure below atmospheric pressure, sealed by water, having an air-water surface above that of adjacent free air-water surfaces^[10].

tortuosity. The ratio of actual length of pore channel to over all length of sample. The sinuosity of actual flow path in a porous medium^[16].

total dissolved solids, TDS. 1. The total concentration of dissolved constituents in solution, usually expressed in milligrams per liter^[22]. 2. The total concentration of dissolved material in water [as] ordinarily determined from the weight of the dry residue remaining after evaporation of the volatile portion of an aliquot of the water sample^[22].

total hydraulic head. See *head, total*.

total pore space. The sum of interconnected and noninterconnected pore space^[16].

total runoff. The sum of all components of runoff into a stream^[16].

total soil-water potential. The sum of the energy-related components of a soil-water system; i.e., the sum of the gravitational, matric, and osmotic components^[22].

tourrelle. (French.) A little tower; applied to small flat-topped buttes of limestone in karst areas. Contrasted with pitons, which have pointed tops, and with coupoles, which have rounded tops^[10].

tower karst, turmkarst. 1. A spectacular variety of karst landscape dominated by steep or vertical sided limestone towers each 30-300 m high. By far the most extensive and best developed tower karst is the Guangxi province of southern China. Towers originate as residual cones and are then steepened by water table undercutting from surround alluviated plains. Tectonic uplift matched by karst erosion then increases tower heights, but if uplift exceeds surface lowering the towers are raised to hillside locations and the landscape is rejuvenated to form a new generation of

dolines and cone karst. Many towers are riddled with relict caves at high levels, and with active caves through their bases^[9]. 2. Karst topography characterized by isolated residual limestone hills displaying numerous shapes (e.g., cone shaped, steep-sided) separated by areas of alluvium or other detrital sand; towers are generally forest-covered hills, and many have flat tops. They may form as isolated hills or in groups. 3. A type of karst topography, common in the tropics, in which the residual hills rise in steep-sided but flat-topped mounds (resembling towers) from intervening depressions or dolinas (sinkholes)^[20]. Synonyms: (French.) *karst à tourelles, karst à tours*; (German.) *Turmkarst, Kegelkarst*; (Italian.) *carsismo con forme residuali a torre*; (Spanish.) *karst de torres*; (Turkish.) *kuleli karst*. See also *cone karst; cupola karst; pinnacle karst; fengcong; fenglin*.

tracers. Materials, such as chemicals, dyes, radioactive salts, and light insoluble solids, introduced into underground waters to determine points of egress of the water and its velocity^[10].

tracer flow method. A method of determining flow velocities and directions by introducing tracers or indicators into ground water^[16].

traction load. See *bed load*.

tranquil flow. Open channel flow with Froude number smaller than unity^[16].

transgression. The spreading of the sea over level areas^[16].

transient. A pulse-dampened oscillation or other temporary phenomena occurring in a system prior to reaching a steady-state condition^[22]. See *flow, unsteady*.

transition zone. 1. Portion of bedrock in the vadose zone that is between the epikarst zone and the phreatic zone, is relatively waterless and unfractured, but is locally breached by discrete percolation points (vadose shafts.) 2. The zone in which the properties of two adjacent units change gradually (freshwater/saltwater). See also *epikarst zone; subcutaneous drain; subcutaneous flow; subcutaneous zone; vadose caves; vadose shafts*.

transit time; travel time. The travel time of a sonic impulse through a given length of rock^[16].

transmission capacity. The property of a porous medium to conduct fluid^[16].

transmissibility coefficient. The use of the term “transmissibility” has been replaced by “transmissivity”^[22]. See *transmissivity*.

transmissivity. The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient^[6]. Though spoken of as a property of the aquifer, it embodies the saturated thickness and the properties of the contained liquid as well. It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the flow paths^[22].

transpiration. The process by which water absorbed by plants, usually through the

roots, is evaporated into the atmosphere from the plant surface^[6].

transpiration depth. The depth of water consumed annually by plants^[16].

transpiration ratio. The ratio of water weight transpired to weight of dry matter produced^[16].

transport. Conveyance of solutes and particulates in flow systems. See also *solute transport; particulate transport*^[22].

transportational process. All processes contributing to the transport of eroded material^[16].

transverse permeability. See *permeability, transverse*.

transverse wave. A wave generated by shearing displacement where wave motion is perpendicular to direction of propagation^[16].

trap. See *siphon; sump; water trap*.

travertine. 1. Hard calcareous mineral deposited by flowing water, that is the same as the calcareous variety of sinter and comparable to the softer tufa. The term is normally used only for deposits formed outside caves, where plants and algae cause the precipitation by extracting carbon dioxide from the water and give travertine its porous structure. Travertine forms most commonly on waterfalls that build up like gour dams. Famous examples include those at Plitvice in Croatia, Dunn’s River Falls in Jamaica, and, largest of all, Band-I-Amir in Afghanistan^[9]. 2. Calcium carbonate, CaCO₃, light in color and generally

concretionary and compact, deposited from solution in ground and surface waters. Extremely porous or cellular varieties are known as calcareous tufa, calcareous sinter, or spring deposit. Compact banded varieties, capable of taking a polish, are called onyx marble or cave onyx^[10]. 3. Generally compact calcium carbonate rock formed by precipitation of soluble bicarbonates when equilibrium is lost through changes in temperature and chemical characteristics. Soft, porous variety is called calcareous tufa^[20]. Synonyms: (French.) *travertin*; (German.) *Kalktuff*, *Sinter*, *Travertin*; (Greek.) *travertinis/asvestolithikos toffos*; (Italian.) *travertino*; (Russian.) *travertin*; (Spanish.) *travertino*, *toba*; (Turkish.) *traverten*, *sutaşı*; (Yugoslavian.) *sedra*, *travertin*, *bigar*, *lehnjak*. Related to *sinter* and *tufa*.

travertine terraces. Terraces and related forms covered by or composed of carbonates precipitated from water. Such precipitation is usually from saturated bicarbonate waters (as from karst) when they enter a zone of turbulent flow^[20]. Synonyms: (French.) *terrasse de travertin*; (German.) *Travertin-Terrasse*; (Greek.) *anavathmos travertinou*; (Italian.) *spianata di travertino*; (Spanish.) *terrazas travertínicas*; (Turkish.) *sutaşı traçaları*; (Yugoslavian.) *slapovi*. See also *constructive waterfall*.

trellis. A geometrical arrangement of an interwoven pattern^[16].

trellis drainage pattern. A arrangement of stream and tributaries in a rectangular fashion^[16].

tributary. A stream contributing its waters to another stream of higher order^[16].

tributary river. A smaller stream entering and contributing to the flow of a larger river^[16].

tributary valley. A less important valley joining a larger valley^[16].

triple point. A point at which the solid, liquid, and vapor phases are in equilibrium^[16].

tripoly. A very fine-grained silica sand^[16].

tritium. An isotope of water, H₃O (HTO), used for tracing ground water and for age dating of ground water^[16]. See also *radioisotope*; *radioactive tracer*; *tracers*.

Trittkarren. (German.) These are best described as *heel-print karren* because they resemble the imprint of a heel. They are nearly connected with subhorizontal, adjacent, flat plains and migrate upslope by cutting “steps” through the process of retrogressive corrosion. The semicircular form is preserved by the “horseshoe falls effect,” which concentrates the main amount of water on the innermost part of the heel-print. At the upper rim the water gain speed. The thickness of the film of water is indirectly proportional to the speed of the flow. A higher rate of flow results in a greater effectiveness of fresh precipitation added to the flow on the ground, but it also causes the diffusion of atmospheric CO₂ and more extensive corrosion. Most Trittkarren originate at the rim of a grike lying below and have moved upward to the surface through retrogressive corrosion. At the base of steep slopes where snow collects,

nearly funnel-shaped Trittkarren appear and are of subnival origin. They are common in the Alps^[3]. Synonym: *heel-print karren*.

trough. A depression usually on the land surface, but can occur in ground water.

troglobite. 1. An animal living permanently underground in the dark zone of caves and only accidentally leaving it^[10]. 2. A creature that is fully adapted to life in total darkness and can only complete its life cycle underground^[13]. 3. A creature that lives permanently underground beyond the daylight zone of a cave. Many troglobitic species are adapted in some way to living in a totally dark environment. Synonyms: (French.) *troglobie*; (German.) *Troglobiont*; (Greek.) *troglothitis*; (Italian.) *troglobio*; (Russian.) *troglobiont*; (Spanish.) *troglobio*; (Turkish.) *troglobit, kör balık*.

troglogyte. A human cave-dweller^[10]. Examples would be early "cave man."

troglophile. 1. An animal that enters beyond the daylight zone of a cave intentionally and habitually and generally spends part of its life in the underground environment. Cave swifts and some bats are troglophiles^[9]. 2. An animal habitually entering the dark zone of a cave but necessarily spending part of its existence outside such as some species of bats^[10].

troglophobe. An animal or person unable physically or psychologically to enter the dark zone of a cave or other underground area^[10].

trogloxene. 1. A creature that will enter a cave on occasions but does not use the cave either for temporary or permanent

habitation^[9]. 2. An animal entering a cave for various reasons but not living there permanently^[10].

true velocity. Ground-water flow velocity in porous interstice or cavernous opening^[16].

truncation. A horizontal or vertical clean cut through a topographic feature^[16].

tsingi. Type of pinnacle karst found on limestone in Madagascar^[9].

tube, lava. See *lava cave*.

tubular passage; tube; tube passage. 1. Cave passage formed by approximately equal dissolution all round when full of flowing water within the phreas. Relict tubes, abandoned as the water table was lowered, are common in old caves, and may be partially filled by sediment, breakdown, or stalagmite, or entrenched to form keyhole passages. Tube sizes range to over 15 m in diameter, but the larger ones are rarely of uniform section. Peak Cavern in Derbyshire is well known for its fine circular phreatic tubes. Some of the trunk passages of Mammoth Cave, Kentucky, are spectacular tubes of elliptical section, formed by dissolution rates that were higher along the bedding than across^[9]. 2. These are nearly horizontal cave passages (tunnels) with round or elliptical cross sections and are either straight or winding. At Mammoth Cave they vary in size up to 30 feet high and nearly 100 feet wide. They are formed while completely filled with flowing water. Although they are typically wider than high as a result of dissolution along horizontal cracks and bedding-plane partings, they may also form as high, narrow, straight fissures along major

vertical or near vertical fractures^[15]. See also *canyon passage*; *keyhole passage*; *passage*; *vertical shaft*.

tubular spring. See *spring*, *tubular*.

tufa. Soft, porous concretions of carbonate reprecipitated from saturated karst water, often around plants^[22]. See also *sinter*; *travertine*.

tunnel. See *natural tunnel*.

turanite. A cave mineral — $\text{Cu}_5(\text{VO}_4)_2(\text{OH})_4$ ^[11].

turbidity. A diminishing of light penetration through a water sample because of suspended and colloidal materials.

turbulence. An irregular motion of fluid particles in an inertia-dominated flow regimen^[16].

turbulent flow. 1. Type of flow that begins to develop in a dissolutional subconduit as its diameter increases to the point where differences between flow velocity at the bounding wall (slowed by friction and adhesion) and the maximum velocity in the tube's center are sufficient to cause development of eddies within the flowing water^[9]. 2. The flow condition in which inertial forces predominate over viscous forces and in which head loss is not linearly related to velocity^[22]. It is typical of flow in surface-water bodies and subsurface conduits in karst terranes, provided that the conduits have a minimum diameter of approximately 2-5 mm although some research has suggested that 5-15 mm, may be more appropriate. See also *laminar*

flow; *Reynolds number*; *turbulent threshold*.

turbulent threshold. The limiting value of subconduit size, below which water flow is essentially laminar and above which water flow includes a significant turbulent component. Subconduit diameters between 5 mm and 15 mm have been suggested as the minimum for turbulent flow, but the value depends upon a variety of factors, including the flow velocity; at low flow velocities laminar flow conditions may persist in tubes up to 500 mm in diameter^[9]. See also *laminar flow*; *Reynolds Number*; *turbulent flow*.

turlough. (Irish.) 1. A karst depression that may be dry or flooded according to season or prevailing weather conditions; derived from the Irish term for “dry lake.” Oscillations in the general ground-water level, including variations in response to local or more distant tidal effects, are the probable mechanism for water level changes in the true turloughs. Effects that appear similar can be produced by high surface runoff into a closed depression with only restricted capacity for the drainage to sink underground^[9]. 2. A depression in limestone or in glacial drift over limestone that is liable to flood either from excess surface runoff or from rising ground water. From the Irish words “tuar loch,” meaning “dry lake”^[10].

Turnkarst. (German.) See *tower karst*.

type curve. A plot of the theoretical well function versus the lower limit of the integral in Theis' graphical solution method^[16]. Numerous variations of Theis' original work have been developed for which type curves readily exist.

tyuyamunite. A cave mineral —
 $\text{Ca}(\text{UO}_2)_2(\text{VO}_4)_2 \cdot n\text{H}_2\text{O}^{[1]}$.

U

unaltered rock. Rock that has not experienced physical or chemical erosion^[16].

unconfined. A condition in which the upper surface of the zone of saturation forms a water table under atmospheric pressure^[22].

unconfined aquifer. An aquifer in which the water table is exposed to the atmosphere through openings in the overlying materials.

unconfined flow. Ground-water flow displaying a free surface^[16].

unconfined water. Ground water vertically in direct contact with the atmosphere^[16].

unconformity. A fossil land surface representing the absence of a sequence of sediments^[16].

unconformity spring. See *spring, unconformity*.

uncontaminated zone. In electrical logging practice, the zone around a borehole that has not become contaminated by mud filtrate^[16].

undercut karren. These are Rinnenkarren (solution grooves) that have been transformed by humus filling and by their side walls having been hollowed under by biogenic CO₂^[3].

underflow spring. See *spring, underflow*.

underdrainage. The drainage from under a hydrologic feature such as a river, barrier, lake, etc.

underfit stream. A small stream that flows along a cave passage that was enlarged to its current size by an earlier, larger stream. Commonly underfit streams are found flowing under vadose conditions along the floors of drained phreatic tubes, long abandoned by the phreatic flow that enlarged them. Underfit streams may also occur if the major flow in a vadose streamway is captured to lower levels by the opening of a new shaft. The main flow no longer uses the downstream passages, leaving any tributaries to amalgamate as an underfit stream^[9].

underflow. Deep phreatic flow within an aquifer, along flow lines that are largely unrelated to the more obvious flow at higher levels. Underflow drainage may be slower than that in shallower systems, and may travel towards more distant and/or unrelated springs^[9].

underground divide. Subsurface watershed between two catchment areas in karst; often incongruent with the surface topography of the area^[20]. Synonyms: (French.) *ligne de partage des eaux souterraines, limit souterrainne*; (German.) *unterirdische Waßerscheide*; (Greek.) *ypoghios ythroketis*; (Italian.) *spartiacque sotterraneo*; (Russian.) *vodorazdel podzemnih vod*; (Spanish.) *divisoria subterránea*; (Turkish.) *yeraltı su bölümü*; (Yugoslavian.) *podzemna razvodnica, podzemna vododelnica*. See also *subsurface divide*.

underground river, underground stream. Water flowing in channels through caves, caverns, and larger galleries in karst terranes^[20]. Synonyms: (French.) *rivière*

souterraine; (German.) *Höhlenfluß*, *unterirdischer Fluß*; (Greek.) *ypoghios roe*, *potamos*; (Italian.) *fiume sotterraneo*; (Russian.) *podzemnaja reka*; (Spanish.) *río subterráneo*; (Turkish.) *yeraltı nehri*, *deresi*; (Yugoslavian.) *podzemni tok*, *podzemna rijka*, *podzemna reka*. See *subterranean river*.

underground waters. All subsurface waters^[16]. Not to be confused with “ground water,” which specifically refers to water within the phreatic zone.

uniaxial (unconfined) compression. Compression caused by the application of normal stress in a single direction.

uniaxial state of stress. The state of stress in which two of the three principal stresses are zero.

uniform flow. Flow with constant velocity at all points and at all times^[16].

uniformity coefficient. A numerical expression of the variety in particle sizes in mixed natural soils, defined as the ratio of the sieve size on which 40% (by weight) of the material is retained to the sieve size on which 90% of the material is retained^[16].

unit-hydrograph. A hypothetical discharge hydrograph for a given point resulting from unit rainfall that produces unit runoff^[16].

unsaturated coefficient of permeability. The apparent coefficient of permeability in flow through an unsaturated medium^[16].

unsaturated flow. 1. The movement of water in a porous medium in which the pore spaces are not filled to capacity with

water^[22]. 2. Two-phase flow through pores only partially filled with water and air^[16].

unsaturated zone. See *vadose zone* and *zone of aeration*.

unsteady flow. Flow with a finite local acceleration term and streamlines that vary with time^[16].

unterirdische karst. See *interstratal karst*.

upconing. Process by which saline water underlying fresh water in an aquifer rises upward into the freshwater zone as a result of pumping water from the freshwater zone^[22].

uplift. 1. The hydrostatic force of water exerted on or underneath a structure tending to cause a displacement of the structure. 2. The relative upward movement of a part of the earth’s crust^[16].

upper confining bed. An impermeable bed overlying an aquifer^[16].

upside-down channel. See *ceiling channel*.

urkarst. See *buried karst*.

uvala. 1. A multi-coned closed depression; now little-used term of Croat, Serb or Bulgarian origin. The term was introduced to describe features assumed to be the second step in a three-stage process of polje development, in which dolines were supposed to coalesce into uvalas. This mechanism is no longer accepted and the term “uvala” has fallen into disuse^[9]. 2. Large closed depression formed by the coalescence of several dolines that have enlarged towards each other. Typically, the

floor is irregular, being a combination of doline floors and degraded slopes of the individual hollows^[19]. 3. A Yugoslavian term for an elongated closed depression in karst that is commonly dry or with periodical small sinking streams or inundations. They are generally a few hundred meters long and may be considered as a small polje^[20]. Synonyms: (American.) *compound doline*; (French.) *cuvala*; (German.) *Uvala*; (Greek.) *ouvala*; (Italian.) *avvalamento carsico*, *uvala*; (Russian.) *uvala*; (Spanish.) *uvala*; (Turkish.) *koyak*; *kokurdan*; (Yugoslavian.) *draga*. See also *canyon*; *karst valley*; *valley sink*. Related to *polje*.

V

vadose cave. 1. A cave that underwent most of its development above the water table. Within the vadose zone, drainage is free-flowing under gravity, and cave passages therefore have air above any water surface. The gravitational control of vadose flow means that all vadose cave passages drain downslope, they exist in the upper part of a karst aquifer, and they ultimately drain into the phreatic zone or out to the surface. Active stream caves, explorable by non-diving cavers, are by definition vadose (though they generally have phreatic origins). Characteristics of vadose caves are uneroded ceilings (except for immature phreatic features predating the vadose conditions) and continuous downhill gradients (unless interrupted by short perched sumps). The main passage forms are canyons, with meanders and potholes, broken by sub-cylindrical, spray-corroded shafts that may demonstrate waterfall retreat. Some of the caves of Monte Canin, Italy, are spectacularly long and deep vadose systems^[9]. 2. Older, higher cave passages found in the vadose zone; usually vadose caves have been abandoned by the ground water except in times of extreme aquifer recharge. Passages usually appear as canyons and keyholes.

vadose shaft. A vertical tube in the vadose zone that may be a few inches to several feet in diameter and may be a few feet deep to hundreds or over a thousand feet deep. They commonly occur as complexes. A drain hole is usually evident at their base. See also *vertical shaft*.

vadose water. 1. That part of the underground water in a karst limestone that

circulates freely under gravity above the level of saturation - the *vadose zone*. Caves formed by flowing water are said to be *vadose caves*^[19]. 2. Water in the zone of aeration; water above the zone of saturation^[10].

vadose zone. 1. The zone between the land surface and the water table^[22]. 2. The zone between the land surface and the deepest water table which includes the capillary fringe. Generally, water in this zone is under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies the water pressure locally may be greater than atmospheric^[22]. When discussing a karst setting, it is preferable to use the term "vadose zone," so as to avoid confusion regarding chemical saturation. Synonym: *unsaturated zone*. See also *zone of aeration*.

valley fill. Unconsolidated debris accumulated on a valley bottom^[16].

valley sink. (American.) An elongated closed depression or series of interconnecting depressions forming a valleylike depression. Compare *karst valley*; *uvula*^[10].

valley spring. See *spring, valley*.

vanadinite. A cave mineral — $\text{Pb}_5(\text{VO}_4)_3\text{Cl}$ ^[11].

vaporization. The process by which liquid or solid water changes into the gaseous state^[16].

variance. The square of the standard deviation^[16].

variscite. A cave mineral — $\text{AlPO}_4 \cdot 2\text{H}_2\text{O}$ ^[11].

varve. The alternating of coarse and fine grained layers in glacial lake sediments^[16].

vasque. A large, shallow solution pan formed in the intertidal zone of warm seas by the action of brine and marine organisms^[19].

vauculian spring; vauculian rising. See *spring, vauculian*.

vegetation cover. The cover living vegetation on top of the upper soil horizon^[16].

vein. A mineral-filled fracture cutting through a host rock. The mineral filling may be derived from the host rock, as is the case with many calcite veins in limestone (e.g., at Marble Showers in Ogof Ffynnon Ddu) or derived from other, generally deeper sources, such as the many veins containing lead and zinc ore minerals in the Derbyshire Peak District, England^[9].

velocity, average interstitial. The average rate of ground-water flow in interstices expressed as the product of hydraulic conductivity and hydraulic gradient divided by the effective porosity. Synonymous with average linear ground-water velocity or effective velocity.

vertical cave. A vertical passage within a cave system, formed along joints by which underground watercourses are transferred from a higher to a lower bedding plane^[19]. They may become transformed into vertical shafts by sufficiently uniform dissolution as to create a rounded vertical passage. See also *fissure cave; vertical shaft*.

vertical shaft. These are formed by underground water dripping of flowing straight downward through the limestone along vertical cracks. Uniformly distributed dissolution of the rock results in a silo- or well-shaped passage so that most of them appear roughly circular in cross section when viewed straight up and down. They form above active tubular passages, although they may intersect a limited number of passages along their length. At Mammoth Cave, they range in size from 30 feet across to 200 feet from top to bottom^[15]. Synonym: *dome-pit*. See also *canyon passage; fissure cave; keyhole passage; passage; tubular passage; vadose shaft; vertical cave*.

vertical caver. A caver who enjoys and is competent doing vertical caving^[13]. See also *vertical caving*.

vertical caving. Caving that includes a lot of ascending and descending^[13]. See also *vertical caver*.

very fine sand. Grain particles with diameters ranging from 0.05 to 0.1 mm^[16].

vesicular. Containing small circular cavities^[16].

victor tube. The single phreatic subconduit among the many that potentially exist on a given bedding plane (or fracture plane) that is the first to reach a diameter capable of establishing turbulent-flow conditions. Following this breakthrough the victor tube tends to enlarge more rapidly than other branching or subparallel alternatives, and eventually captures much of the drainage within its field of influence^[9].

virgin flow. Flow unaffected by artificial diversions, impoundments, or channels^[16].

virgin passage. A cave passage that has not previously been entered; a new discovery^[13].

viscosity. 1. The resistance of liquid to flow^[16]. 2. The property of a real fluid creating shear forces between two fluid elements and giving rise to fluid friction^[16]. Specifically, it is the ratio of the shear stress to the rate of shear strain^[6].

void. See *interstice*.

void ratio. The ratio of the volume of void space to the volume of solid particles in a given soil mass^[22].

volatiles. Substances with relatively large vapor pressures. Many organic substances are almost insoluble in water, so they occur primarily in a gas phase in contact with water, even though their vapor pressure may be very small^[22].

volumetric flowmeter. Apparatus designed to measure a volume flow rate^[16].

volumetric moisture content. The concentration of water in soil by volume^[16].

vrulje. (Yugoslavian.) See *submarine spring*.

vug. A small cavity in rock usually lined with crystals. Adjective, *vuggy*^[10]. See also *geode*.

vugular pore space. Void space due to solution cavities of small size^[16].

vulcanokarst. An area comprised of tubular caves within lava flows and showing evidence of mechanical collapse of the roof into them. See also *lava cave*; *pseudokarst*.

W

wading measurement. Discharge measurement during which a hydrographer takes readings while standing in a river^[16].

wall block. A roughly cubical joint-controlled large block of limestone or dolomite, which has rotated outward from a cave wall^[10]. See also *cave breakdown*; *wall slab*.

wall karren. These are found on vertical walls as a result of water flowing down the walls without any areawide moistening, although areawide sprinkling occasionally influences their development^[3]. See also *meandering karren*; *humus-water grooves*.

wall pocket. See *pocket*.

wall slab. A thin but large block of rock, which has fallen outward from the wall of a cave in limestone in which the dip is nearly vertical^[10]. See also *cave breakdown*.

wang. (Malaysian.) Polje^[10].

wash. A small ravine caused by outwash from flow in desert regions^[16].

wash load. The incoming load of suspended sediment passing through a river network without deposition^[16].

waste load. The content of wastes by weight of volume transported by or discharged into a river^[16].

waste water. Water containing sewage and waste products^[16].

water-balance. An instrument designed to measure evaporation by gravimetry^[16].

water-bearing. Containing water^[16].

water-borne disease. Disease spread by organic contaminants contained in the water supply^[16].

water budget. The quantitative accounting of water volumes involved in the hydrologic cycle^[16].

water catchment. The intake of water from an aquifer or a surface reservoir^[16].

water conservation. All measures to reduce the quantitative of qualitative spoilage of water^[16].

water content. The amount of water lost from the soil after drying it to constant weight at 105°C, expressed either as the weight of water per unit weight of dry soil or as the volume of water per unit bulk volume of soil^[22]. See *moisture content*.

water course. Any channel conveying water^[16].

water equivalent. The depth of water resulting from the melting of snow^[16].

water hammer. An abnormally high pressure rise in a pipe when sudden changes in flow occur^[16].

water-holding capacity. See *specific retention*.

water invasion. The sudden invasion of water into a well or borehole^[16].

water level. The level of free surface of a water body or water column^[16].

water logged, waterlogged. Water saturated^[16].

water logging. Water accumulation on top of soil where the water table and ground surface coincide^[16].

water of constitution. Chemically bound water^[16].

water of crystallization. Water embodied in crystal structure^[16].

water of dehydration. Water freed from hydrous minerals by chemical changes^[16].

water pot. See *kamenica, solution pan*.

water quality. The physical, chemical, and biological characteristics of water^[16].

water requirement. The quantity of water needed for crops regardless of the source^[16].

water resources. The total supply of surface, ground, and reclaimed water that can be used^[16].

water stage. The height of the water level^[16].

water table. 1. The top surface of a body of slowly moving ground water that fills the pore spaces within a rock mass. Above it lies the freely draining vadose zone, and below it lies the permanently saturated phreatic. In uniform aquifers, such as sandstone, the water table is a smoothly contoured surface intersecting the ground at rivers and lakes, but in limestone it is more complex. Individual cave conduits may be above or below the water table, and therefore either vadose or phreatic, and the

water table cannot normally be related to them. The water table concept does, however, apply to the diffuse drainage of percolation water in the microfissure network of limestone, but its detailed structure may be complicated by the presence of conduits. The water-table slope (hydraulic gradient) is low in limestone due to the high permeability, and the level is controlled by outlet springs or local geological features. High flows create steeper hydraulic gradients and hence rises in the water level away from the spring. In France's Grotte de la Luire, the water level in the cave (and therefore the local water table) fluctuates by 450 m^[9]. 2. The upper surface of a zone of saturation except where that surface is formed by a confining unit^[22]. 3. The upper surface of the zone of saturation on which the water pressure in the porous medium equals atmospheric pressure^[22]. 4. The upper boundary of an unconfined zone of saturation, along which the hydrostatic pressure is equal to the atmospheric pressure^[10]. See also *potentiometric surface*.

water-table aquifer. See *unconfined aquifer*.

water-table cave. In theory the water table offers the prime environment for cave development, as it provides the shortest route through the phreatic and is potentially more active chemically because of the presence of the air/water interface. However, geological factors determine the details of cave inception and enlargement, and passages most commonly form just below the water table as a shallow phreatic variety of cave development. Development of this type is believed to be responsible for the "levels" of cave passage found in some areas, as in the flint Mammoth Cave

System, Kentucky. True water-table caves are rare, except on a limited scale as extensions to cliff foot notches margined to tropical swamps. Also, under these conditions, the water table may adjust down to the level of a mature phreatic cave and then modify the passage with horizontal dissolution notches — as is common in the caves of Mulu and Niah, Sarawak^[9].

water-table divide. See *divide*.

water-table map. A map showing the upper surface of the phreatic zone of a water-table aquifer by means of contour lines^[1]. See also *phreatic zone*; *potentiometric-surface map*; *water-table aquifer*.

water tracing. Underground drainage links through unexplored caves confirmed by labeling input water and identifying it at points downstream. The common labeling techniques involve the use of fluorescent dyes (fluorescein, rhodamine, leucophor, pyranine, etc.), lycopodium spores, or chemicals such as common salt. Detection of dye downstream may be purely visual, but if the dye is used at a subvisible (environmentally acceptable) dilution, suitable detectors must be placed in all potential risings and collected for subsequent fluorometric examination (although water samples are more desirable and beneficial). Lycopodium spores are usually collected in fine nets, along with other streamborne sediment, and must then be identified under the microscope. If chemical tracers are used, regular water samples must be collected for subsequent analysis, or the resurgent waters must be monitored with suitable electronic detectors and recorders. Flowpaths can also be confirmed by transmission of artificial or

natural flood pulses, which provide additional data on the nature of conduits, as a pulse is transmitted instantaneously through flooded passages. The longest successful water trace was from Beysehir Golu to the Manavgat springs, in Turkey, over a distance of 130 km; 390 kg of fluorescein was used and the dye reappeared after 366 days^[9].

water trap. A place where the roof of a chamber or passage of a cave dips under water but lifts again farther on^[10].
Synonym: *trap*.

water works. A plant where water is treated and prepared for municipal consumption^[16].

water year. A 12-month period for streamflow computation^[16].

waterlogging. Water accumulation on top of soil where the water table and ground surface coincide.

watershed. 1. A drainage basin^[16]. 2. A divide separating one drainage basin from another^[16].

waterway. An artificial or natural watercourse fit for navigation.

wave karren. Wavy karren surfaces that appear similar to corrugated tin. When denuded they are a disposition for the formation of Rinnenkarren^[3]. See also *covered karren*; *Rinnenkarren*; *root karren*.

wayboard. One of many thin beds of volcanic clay that occur at intervals within the Carboniferous carbonate succession of the Peak District, England; a term formerly

used by lead miners (see *toadstone*). Wayboards have potential significance during speleogenesis, when they may act as local aquicludes, inception horizons, or providers of strong acid formed by oxidation of sulfide minerals^[9].

weathering. The process of disintegration and decomposition as a consequence of exposure to the atmosphere, to chemical action, and to the action of frost, water, and heat.

wedge storage. 1. Water storage in the form of a wedge overlying a prism^[16]. 2. Storage in a flooded river segment^[16].

weir. A dam across a water course to control, raise, or measure water flow^[16].

weir coefficient. A coefficient used in transforming water depths into discharge volumes in weir measurements^[16].

well. 1. A shaft or hole sunk into the earth to obtain water, oil, gas, or minerals^[10]. 2. A deep vertical rounded hole or shaft in the floor of a cave or at the bottom of a closed depression^[10]. 3. A bored, drilled or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension^[22].

well function. An exponential integral as used in Theis' nonequilibrium equation^[16].

well hydrograph. A graph of water level fluctuations in a well^[16].

well loss. Head loss caused by flow through a screen and inside a well^[16].

well-sorted grains. An assortment of grains having the same diameter^[16].

well yield. The volume of water discharged from a well in gallons per minute or cubic meters per day.

wet line. That portion of line submerged under water in stream measurements^[16].

wetland. A general term used for a group of wet habitats, in common use by specialists in wildlife management. It includes areas that are permanently wet and/or intermittently water-covered, especially coastal marshes, tidal swamps and flats, and associated pools, sloughs, and bayous^[1].

wettability. The property of a solid substance to be wetted by a liquid such as water^[16].

wetted area. The cross-sectional area of that portion of a channel that is filled with water^[16].

wetted perimeter. The perimeter over which flowing water is in actual contact with the channel walls and bottom^[16].

wetting period. The period of contact between a liquid and a solid surface during which wetting occurs^[16].

whitlockite. A cave mineral — $\text{Ca}_9(\text{Mg,Fe})\text{H}(\text{PO}_4)_7$ ^[11].

width of contribution. The width of the contributing region between the ground-water divide from which water enters a well. This usually occurs with an inclined piezometric surface^[16].

wilt, to. The shrinking of cell walls due to loss in turgor as a result of water deficiency in the plant^[16].

wilting coefficient, wilting point. The soil moisture content at which plants wilt^[16].

wind factor. The factor containing a monthly mean wind velocity in evaporation^[16].

wind field. The air velocity field above ground due to wind action^[16].

window. 1. In speleology, a natural opening above the floor of a passage or a room, giving access to an adjoining cavity or to the surface; larger and less symmetrical than a porthole. 2. The opening under the arch of a small natural bridge^[10]. See *karst window*.

windypit. Open fissure, widened by landslip, common in valley side situations in which limestone overlies weaker rocks such as clays or shales. The term is commonly used to describe gulls and tectonic caves in the Jurassic limestones of northeast Yorkshire, England^[9].

withdraw, to. To draw water from an aquifer or reservoir^[16].

workover. The reworking of a well that has declined in yield^[16].

Y

yield. The quantity of water discharged from an aquifer¹⁶¹ (e.g., spring or well.) See also *well yield*.

Z

zadernovannyĭ karst. (Russian.) See *subsoil karst*.

zakrytyĭ karst, skrytyĭ karst. (Russian.) See *closed karst*.

zanjón. (Spanish.) In Puerto Rico, solution trench in limestone. Zanjónes range from a few centimeters to about 8 meters in width and from about 1 to 4 meters in depth. Apparently they form by the widening and deepening of joints by solution^[10]. See also *bogaz*; *corridor*; *struga*.

zero adjustment. The adjustment of a scale or a measuring circuit to an original point of departure^[16].

zonal soil profile. The normal horizontal distribution of soil zone^[16].

zone of accumulation. The second horizon of a soil profile (B), usually the zone of clay accumulation subjacent to zone (A)^[16].

zone of aeration. The zone in permeable soil or rock that is above the zone saturated with water; the zone of vadose water^[10]. See also *vadose zone*.

zone of investigation. The zone over which a given measuring device is able to obtain information^[16].

zone of leaching. The top horizon of a soil profile (A) that is most intensely weathered^[16].

zone of saturation. The zone in permeable soil or rock that is saturated with water; the phreatic zone^[10]. See also *phreatic zone*.

zones of karstification. Cvijič (1926, 1960) distinguishes three zones of karstification: (1) dry zone in the upper part of the karst with caves almost completely dry; (2) transition zone where water flows downstream almost permanently; and (3) deep zone with slow downstream flow and local siphons^[20]. Synonyms: (French.) *zones de karstification*; (German.) *Zone der Verkarstung*; (Greek.) *zoni karstikopiiseos*; (Italian.) *zone idrogeologica*; (Spanish.) *zona de karstificación*; (Turkish.) *karstlaşma kuşağı*; (Yugoslavian.) *zone karstifikacije*.

Zwischenhöhle. (German.) Cave in which a river passage, or former river passage, is entered from above or laterally and which can be followed upstream and downstream some distance but not to daylight^[10].

REFERENCES

1. Bates, R. L., and J. A. Jackson. 1980. Glossary of Geology. American Geological Institute, Falls Church, Va. 751 pp.
2. Bear, J. 1979. Hydraulics of Groundwater. McGraw-Hill Inc., New York. 569 pp.
3. Bögli, A. 1980. Karst Hydrology and Physical Speleology. Springer-Verlag, Berlin. 284 pp.
4. Daoxian, Y. 1985. New observations on tower karst. Paper presented at the 1st International Conference on Geomorphology (Manchester, England). 14 pp.
5. Dreybrodt, W. 1988. Processes in Karst Systems: Physics. Chemistry. and Geology. Springer-Verlag, New York. 288 pp.
6. Driscoll, F. G. 1986. Groundwater and Wells. Johnson Division, St. Paul, Minn. 1089 pp.
7. Ford, D. C., and P. W. Williams. 1989. Karst Geomorphology and Hydrology. Unwin Hyman Inc., Lakeland, Fla. 601 pp.
8. Jennings, J. N. 1985. Karst Geomorphology. Basil Blackwell Inc., New York. 293 pp.
9. Lowe, D., and T. Waltham. 1995. A Dictionary of Karst and Caves: A Brief Guide to the Terminology and Concepts of Cave and Karst Science. Cave Studies Series Number 6. British Cave Research Association, London. 41 pp.
10. Monroe, W. H. (Compiler). 1970. A Glossary of Karst Terminology. Geological Survey Water-Supply Paper 1899-K. U.S. Geological Survey. U.S. Government Printing Office, Washington, D.C. 26 pp.
11. Moore, G. W., and G. N. Sullivan. 1978. Speleology: The Study of Caves. 2nd Edition. Cave Books., St. Louis, Missouri. 150 pp.
12. Myroie, J. E. 1984. Hydrologic classification of caves and karst. Groundwater as a Geomorphic Agent. R. G. LaFleur, Editor. Allen & Unwin. Inc. Boston. pp. 157-172.
13. NSS. 1982. Glossary of caving terms used in this manual. Caving Basics. J. Hassemer, Editor. National Speleological Society, Huntsville, Ala. pp. 124-125.
14. Palmer, A. N. 1972. Dynamics of a sinking stream system: Onesquethaw Cave, New York. National Speleological Society Bulletin. 34. pp. 89-110.

15. Palmer, A. N. 1981. A Geological Guide to Mammoth Cave National Park. Zephyrus Press, Teaneck, N.J. 196 pp.
16. Pfankuch, H. O. 1971. Elsevier's Dictionary of Hydrogeology. American Elsevier Publishing Company, Inc., New York. 168 pp.
17. Quinlan, J. F. 1978. Types of Karst, with Emphasis on Cover Beds in Their Classification and Development. Unpublished Ph.D. Dissertation, The University of Texas at Austin. 323 pp.
18. Quinlan, J. F., P. L. Smart, G. M. Schindel, E. C. Alexander, A. J. Edwards, and A. Richard Smith. 1991. Recommended administrative/regulatory definition of karst aquifer, principles for classification of carbonate aquifers, practical evaluation of vulnerability of karst aquifers, and determination of optimum sampling frequency at springs. Hydrology, Ecology, Monitoring, and Management of Ground Water in Karst Terranes Conference (Nashville, Tenn., 1991). J. F. Quinlan and A. Stanley, Editors. National Ground Water Association, Dublin, Ohio. pp. 573-635.
19. Sweeting, M. M. 1973. Karst Landforms. Selected Glossary. Compiled by K. Addison. Columbia University Press, New York. 362 pp.
20. UNESCO. 1972. Glossary and Multilingual Equivalents of Karst Terms. United Nations Educational, Scientific, and Cultural Organization, Paris. 72 pp.
21. UNESCO. 1984. Guidebook to Studies of Land Subsidence Due to Ground-Water withdrawal. Prepared for the International Hydrological Programme. Working Group 8.4. J. F. Poland, Editor. United Nations Educational, Scientific, and Cultural Organization, Paris. 305 pp. (plus appendices).
22. USGS. (1989). Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport. Prepared by the Subsurface-Water Glossary Working Group, Ground-Water Subcommittee, Interagency Advisory Committee on Water Data. Dept. of the Interior, U.S. Geological Survey, Office of Water Data Coordination. 38 pp.