

The following glossary of terms was taken from “Health Effects of Mineral Dusts,” Reviews in Mineralogy, vol. 28, edited by George Guthrie and Brooke Mossman. It was slightly modified by Mickey Gunter for use in the NAGT workshop on Geology and Human Health, Spring 2004, and reproduced here with permission of the Mineralogical Society of America. Thanks to Paul Ribbe for providing the text file.

The following glossary contains several biological and geological terms that may be unfamiliar to some readers. A more thorough listing of terms can be found in a general scientific dictionary, such as *Dictionary of Scientific and Technical Terms* (1989, 4th edition, S.P. Parker, Editor, McGraw Hill, New York, 2138 pp.), or in dictionaries specific to each of the disciplines (e.g., *Glossary of Geology*, 1980, 2nd edition, R.L. Bates and J.A. Jackson, Editors, American Geological Institute, Falls Church, Virginia, 751 pp.; *Stedman’s Medical Dictionary*, 1990, 25th edition, W.R. Hensyl, Editor, Williams and Wilkins, Baltimore, Maryland, 1784 pp.). Many of the definitions below are modified from these sources. Accepted mineral species names and formulae can be found in the *Mineral Reference Manual* (1991, E.H. Nickel and M.C. Nichols, van Nostrand Reinhold, New York, 250 pp.), and we have generally followed their usage. However, in some cases, errors in the *Mineral Reference Manual* have been corrected here. The editors assume ultimate responsibility for the correctness of the following definitions. However, we acknowledge the assistance of many in developing this glossary, including the authors of chapters in this book and H.C.W. Skinner. Many of the definitions below use words that are also defined in the glossary, and these words are generally italicized.

a-axis: One of the three principle axes used to describe the coordinate system of a crystal structure. See *crystallographic axes*.

accessory mineral: Any mineral that is present in a rock but is not essential to classifying the rock. Generally accessory minerals are present in minor quantities.

acicular: Said of a crystal that is needlelike in form. A high aspect ratio mineral particle formed during growth or crushing. See *asbestiform*, *fibrous*, *prismatic*, *equant*, *tabular*.

actinolite: An amphibole with the ideal composition $\text{Ca}_2(\text{Mg},\text{Fe}^{2+})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$.

Actinolite is a species in the Mg–Fe²⁺ series, tremolite–ferro-actinolite, with $0.9 > \text{Mg}/(\text{Mg}+\text{Fe}^{2+}) > 0.5$. See *amphibole*, *ferro-actinolite*, *tremolite*.

activation energy: The additional energy required to allow a system to proceed from one energy state to another, e.g., to make a reaction proceed.

active oxygen species: Oxygen free radicals. Reactive metabolites or reduced species of oxygen that can react with cellular targets, including DNA. These species possess a non-equilibrium number of electrons (i.e., they possess an unpaired electron), such that the species is unstable and can function as either an electron donor/acceptor or a proton donor/acceptor. See *hydroxyl radical*, *superoxide*.

additive: The condition when two or more agents induce a biological response that is the sum of the weighted biological responses of each agent individually.

aeolian: See *eolian*.

AEM: Analytical electron microscopy. This is typically done using a transmission electron microscope equipped with a capability such as energy-dispersive spectrometry. By performing AEM with a transmission electron microscope, addition important mineralogical

information may be obtained, such as electron diffraction information, particle morphology, microstructures, etc.

AES: Auger electron spectroscopy.

AFM: Atomic force microscopy or atomic force microscope.

agate: A type of microcrystalline quartz.

akaganeite: β -FeOOH. See *lepidocrocite* and *goethite*.

alkali feldspar: A feldspar with an ideal composition of (K,Na)AlSi₃O₈.

allophane: A amorphous clay with a composition approximating that of the kaolin group.

alteration: In mineralogy, any change in the chemical or mineralogical composition of a rock or mineral, typically resulting from the interaction between a mineral and an aqueous fluid. Often, the alteration process involves the introduction of some constituents (e.g., H₂O, cations, or anions) and the release of other constituents of the mineral. Weathering reactions are one example of mineral alteration.

alumina: A chemical term for aluminum oxide, Al₂O₃. See *corundum*.

alveoli: Small sacs or compartments located at the terminus of the respiratory tract. Alveoli are the sites at which gaseous exchange with the blood occurs.

Ames assay: A bacterial assay used to assess the mutagenic potential of an agent.

amesite: A 1:1 layer silicate with an ideal composition of Mg₂Al[SiAl]₂O₅(OH)₄.

amosite: A varietal name for brown (or sometimes gray) asbestos. Amosite was derived from the acronym for Asbestos Mines of South Africa (AMOSAs) and it is a commercial term (i.e., it refers to a product and not a mineral). Amosite generally implies asbestiform cummingtonite–grunerite; however, some amosite samples have been reported to contain other asbestiform amphiboles as well, including anthophyllite, actinolite, and riebeckite. The mineral content may vary from sample to sample, because different source materials may have been used. If the mineral species in a sample is known to be cummingtonite or grunerite, the terms asbestiform cummingtonite or asbestiform grunerite can be used to provide more detailed information. See *amphibole*, *cummingtonite*, *grunerite*.

amorphous: Lacking long-range, periodic atomic order or translational symmetry. Non-crystalline.

amphibole: A mineral group of chain silicates possessing a double-chain structure with an ideal composition of AB₂C₅T₈O₂₂(OH,F,Cl)₂. The A-site is 6- to 12-coordinated and can be unoccupied or can contain monovalent cations (e.g., K or Na); the B site is represented by the M₄ crystallographic site, which is 6-, 7-, or 8-coordinated and can contain Mg, Fe²⁺, Ca, or Na; the C site is represented by the M₁, M₂, and M₃ crystallographic sites, which are octahedrally coordinated and can contain Mg, Fe²⁺, Al, Fe³⁺, Ti, Mn, and Li; and the T-site is tetrahedrally coordinated and generally contains Si⁴⁺ but can also accommodate Al³⁺.

anatase: A mineral species that is a polymorph of TiO₂. See *brookite* and *rutile*.

anionic group: A molecular unit possessing a net negative charge. SiO_4^{4-} and CO_3^{2-} are examples of anionic groups.

antagonistic: The condition when two or more agents induce a biological response that is less than the sum of the weighted biological responses of each agent alone, e.g., one agent inhibits the response of another.

anthophyllite: A species of amphibole with the ideal composition of $(\text{Mg,Fe}^{2+})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$. The iron content of anthophyllite is typically small but not zero. Anthophyllite differs from *magnesio-cummingtonite* in that it possess an orthorhombic structure.

anthropogenic: Relating to the impact of man on nature. That which is found in the environment but which was created by humans.

antigorite: A serpentine mineral with corrugated layers and a composition that differs slightly from the ideal composition for chrysotile and lizardite.

antibody: An immune or protective protein that reacts with a specific antigen on foreign material (e.g., bacteria or viruses), i.e., the antibody possess structural components that complement structural components on the antigen. The binding of the antibody to the antigen aids the immune response by processes such as targeting foreign bodies for phagocytosis or neutralizing infectious agents. See *immunoglobulin*.

antigen: A molecule that induces the production of an antibody.

antioxidants: Naturally occurring or synthetic scavengers of active oxygen species.

AOS: See *active oxygen species*.

apical oxygen: In polymerized sheets of tetrahedra, the apical oxygens are those not shared between tetrahedra. See *basal oxygen*.

arachidonic acid: An unsaturated fatty acid essential in nutrition. A precursor of the eicosanoids, a group of physiologically active substances (e.g., leukotrienes, which mediate inflammation and are involved in allergic reactions, and prostaglandins, which affect vasodilation/constriction and stimulate bronchial smooth muscle, as well as other functions).

asbestiform: An adjective describing inorganic materials that possess the form and appearance of asbestos. Asbestiform is a subset of fibrous, where asbestiform implies relatively small fiber thickness and large fiber length, flexibility, easy separability, and a parallel arrangement of the fibers in native (unprocessed) samples. Often, asbestos fibers occur in bundles, i.e., they are often polyfilamentous. See *acicular, fibrous, prismatic, equant, tabular*.

asbestos: A term applied to asbestiform varieties of serpentine and amphibole, particularly chrysotile, "crocidolite," "amosite," asbestiform tremolite, asbestiform actinolite, and asbestiform anthophyllite. The asbestos minerals possess *asbestiform* characteristics.

asbestosis: A fibrotic lung disease associated with inhalation of asbestos. The disease is characterized by the inability of the lung to oxygenate blood or to eliminate carbon dioxide and a decrease in the ability to expand or to respond to the action of the diaphragm.

aspect ratio: The ratio of length to width.

atomic positions: The position of atoms within a crystal structure. See *fractional coordinates*.

attapulgitite: A varietal term for palygorskite. Attapulgitite is not a mineral species name. Often the distinction between attapulgitite and palygorskite has been that one is fibrous and the other is not. However, industrial usage often assumes attapulgitite is non-fibrous, whereas biological usage often assumes attapulgitite is fibrous. The term attapulgitite should not be used; rather palygorskite should be used in conjunction with modifiers such as fibrous or non-fibrous. See *palygorskite*.

authigenic: Said of minerals or rock constituents formed or generated in place.

autocrine effect: See *cytokine*.

b-axis: One of the three principle axes used to describe the coordinate system of a crystal structure.

basal oxygen: In polymerized sheets of tetrahedra, the basal oxygens are those shared between tetrahedra. See *apical oxygen*.

bentonite: A soft, plastic, porous rock that contains major amounts of clay minerals, particularly montmorillonite.

berthierine: A 1:1 layer silicate with an ideal composition of $(\text{Fe,Al})_3(\text{Si,Al})_2\text{O}_5(\text{OH})_4$. Berthierine-1M and berthierine-1H are the two ordered *polytypes* observed for berthierine.

biopyribole: See *pyribole*.

biotite: A series of 2:1 layer silicates of ideal composition $\text{K}(\text{Mg,Fe})_3\text{Si}_4\text{O}_{10}(\text{OH})_2$. Phlogopite is the magnesium end member of the series, and annite is the iron end member.

blue asbestos: See *crocidolite*.

boehmite: $\gamma\text{-AlOOH}$. See *diaspore*.

Brazil twin: A common type of twin in quartz, resulting from regions with different chirality or handedness. See *Dauphiné twin*.

bridging oxygen: An oxygen atom shared between two coordination polyhedra, particularly tetrahedra.

bright-field TEM image: An image formed using the central (“undiffracted”) electron beam. Regions that scatter electrons strongly appear dark, and regions that do not scatter electrons appear bright. The scattering responsible for the variation in image contrast can result from structural differences (e.g., diffraction related to the orientation of a crystal) or from compositional differences (e.g., diffuse scattering from large atoms). See *dark-field TEM image*.

brindleyite: A 1:1 layer silicate with an ideal composition of $(\text{Ni,Al})_3(\text{Si,Al})_2\text{O}_5(\text{OH})_4$.

bronchus: One of two primary branches of the respiratory tract below the trachea.

bronchiole: Small, thin-walled branch of a bronchus. Bronchioles usually terminate in alveoli.

brookite: A mineral species that is a polymorph of TiO_2 .

brown asbestos: See *amosite*.

brucite: Magnesium hydroxide $[\text{Mg}(\text{OH})_2]$ that generally exhibits a planar morphology. However, a fibrous variety (*nemalite*) also occurs.

byssolite: A fibrous variety of amphibole. Dana restricted the term to the stiff, fibrous variety of actinolite (see Ch. 3 under “Byssolite and nephrite”). Also, a variety of quartz containing fibrous inclusions of actinolite or asbestos.

c-axis: One of the three principle axes used to describe the coordinate system of a crystal structure.

calcified: In biology, a process whereby tissue or noncellular material in the body is hardened as a result of the precipitation of calcium and magnesium salts, particularly calcium carbonate and phosphate.

carcinogen: A cancer-causing agent.

carcinogenic: Possessing the ability to induce cancer.

carcinogenesis: The process of cancer development. Carcinogenesis can be divided into the initiation phase (implying interaction with DNA) and the promotion or progression phase (implying alterations in replication affecting cell division and conversion to malignancy).

chabazite: A species of zeolite with ideal composition $\text{Ca}(\text{Al}_2\text{Si}_4)\text{O}_{12}\cdot 6\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the mordenite structure. See *zeolite*.

chalcedony: A type of microcrystalline quartz.

chain silicate: A mineral class consisting of species with SiO_4^{4-} tetrahedra polymerized in one dimension. Included in this class are the amphiboles, pyroxenes, and pyroxenoids.

chemography: In mineralogy, the graphical representation of mineral compositions in terms of end-member components.

Chemokines: A family of 8 to 10-kd proteins that possess chemoattractant activity for a variety of cell types (e.g., monocytes, neutrophils, lymphocytes, and fibroblasts). Chemokines are important mediators of inflammation and tissue repair processes.

chemotaxis: Movement of cells or organisms in response to chemicals. *chemotactic*, adj.

chert: A type of microcrystalline quartz.

chlorite: A layer silicate characterized by 2:1 layers alternating with hydroxide sheets. Compositionally, chlorites can be similar to 1:1 layer silicates such as the serpentine- and kaolin-group minerals.

chrysotile: A subgroup name for tubular serpentine minerals of ideal composition $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$. The term chrysotile can be modified by the prefixes ortho-, clino-, and para- to identify the crystallographic arrangement of the sheets in the structure. The

resulting terms (“orthochrysotile,” “clinochrysotile,” and “parachrysotile”) are mineral-species names. Chrysotile is frequently (but not always) asbestiform. See *serpentine*.

clay: In geology, this term is applied to particles $<4 \mu\text{m}$, because this size is approximately the upper size limit for particles exhibiting colloidal properties. However, in soil science, the term applies to particles $<2 \mu\text{m}$, and in engineering, the term applies to particles $\leq 74 \mu\text{m}$. Clay also refers to any fine-grained layer silicate, such as chrysotile, kaolinite, smectite (chief constituent of bentonite), and illite.

cleavage: The property of an individual crystal to fracture or break along crystallographically defined planes determined by the structure of the material. Cleavage can be pronounced (as in the cleavage that produces the sheets in micas), to weak, to absent (as in materials such as glasses). Minerals can possess more than one cleavage direction. *C.f., parting.*

clino-: A prefix used to connote a monoclinic structure, e.g., clinoptilolite is the monoclinic variety of the mineral ptilolite (a formerly used term for mordenite).

clinoptilolite: A zeolite with the ideal composition $(\text{Na,K})_6(\text{Al}_6\text{Si}_{30})\text{O}_{72} \cdot 20 \text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the clinoptilolite structure. Natural clinoptilolite is generally non-fibrous. See *zeolite*.

cocarcinogen: An agent that is generally not carcinogenic by itself but may increase the tumor yield of a known carcinogen.

coesite: A high pressure polymorph of SiO_2 .

cohort: A group of individuals with similar backgrounds or characteristics. Cohorts are used in epidemiological studies to determine the biological effects related to a specific activity or agent.

collagen: A fibrous protein found in the connective tissue. Also, the principle component of scar tissue that forms during fibrosis of the lung.

comminution: Pulverization or reduction to minute particles.

complement: A protein complex, normally present in the serum. The activation of complement is part the immune response and involves a sequence of events leading to the destruction of certain bacteria and other cells.

confluence: The condition when cells in culture have reached a monolayer coverage and growth rate diminishes.

congruent: See *dissolution*.

connective tissue: A collection of similar cells and intercellular substances that for the framework of the animal body.

coordination number: The number of an ion’s nearest neighboring ions.

coordination polyhedron: A volume described by an ion’s nearest neighboring ions. Typically, minerals are represented by coordination polyhedra consisting of a cation in the interior of the polyhedron and anions at the apices of the polyhedron. *Tetrahedra* and *octahedra* are examples of coordination polyhedra.

coordination structure: A crystal structure that can be represented with coordination polyhedra.

corundum: A mineral species that is a polymorph of $\text{Al}_2\text{O}_3 = \alpha\text{-Al}_2\text{O}_3$. Corundum is isostructural with hematite ($\alpha\text{-Fe}_2\text{O}_3$).

cristobalite: A polymorph of SiO_2 . The field of stability for cristobalite occurs at high temperature; however, cristobalite can exist or even grown metastably at low temperature.

crocidolite: A varietal name for blue asbestos, usually asbestiform riebeckite. If the mineral species in a sample is known to be riebeckite, the term asbestiform riebeckite can be used to provide greater detail. See *amphibole*, *riebeckite*.

cronstedtite: A 1:1 layer silicate with the ideal composition $\text{Fe}_2^{2+} \text{Fe}^{3+}(\text{Si,Fe})_2\text{O}_5(\text{OH})_4$. There are a number of polytypes with specific mineral species names.

crystal: A homogeneous, solid body of a chemical element, compound, or solid solution having a regularly repeating atomic arrangement.

crystal structure: The structure of a crystalline material, i.e., a material possessing long-range periodic order and translational symmetry. Mineral crystal structures are typically represented using a unit cell, which defines a subset of the entire structure. The entire structure can then be produced by translating the unit cell along the cell edges. The shape of the unit cell is described with axes (a , b , and c) and their angular relationships ($\alpha = \angle b\angle c$, $\beta = \angle a\angle c$, and $\gamma = \angle a\angle b$), and these also define the coordinate system used to describe atomic positions. The magnitudes of these axes and the angles between them (i.e., the lattice parameters) are denoted by a , b , c , α , β , and γ . Atomic positions are generally described in terms of fractional coordinates, which give the positions of the atom relative to the origin of the unit cell. The origin has the coordinates (x,y,z) of (0,0,0); the corner of the cell at the end of the a -axis has the coordinates (1,0,0); the b -axis has the coordinates (0,1,0); and so on. An atom half-way along the b - and c -axes has the coordinates (0,0.5,0.5). This notation for coordinates should not be confused with the notation for *Miller indices*, which are used to describe the orientation of a crystal face. Another similar notation is used to describe the orientation of a vector, e.g., [100] describes a vector of unit length along the direction of the a -axis. In general, these notations for vectors and planes differ from the notation for atomic coordinates by the absence of commas separating the values. The above description provides information on the ideal structure of the crystal, as determined by techniques that measure the average properties of a crystal (e.g., X-ray diffraction). Most natural materials, however, deviate from the ideal structure. These deviations include compositional variations, slight displacements in atom positions, and other defects. These properties can be measured with techniques that examine local environments, such as IR spectroscopy or transmission electron microscopy.

crystalline: An adjective to describe any material possessing the properties of a crystal, i.e., long-range translational periodicity.

crystallographic axis: One of the three vectors (a , b , and c) that define the unit cell of a crystal. The lattice parameters (a , b , and c) refer to the lengths (magnitudes) of the vectors a , b , and c .

crystallographic plane: See *Miller indices*.

culture: The propagation of microorganisms or cells on or in media.

cummingtonite: A series of amphiboles with the generalized composition $(\text{Mg}, \text{Fe}^{2+})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$. Three mineral species constitute this series: magnesio-cummingtonite with $\text{Mg}/(\text{Mg}+\text{Fe}^{2+}) > 0.7$; cummingtonite with $0.7 > \text{Mg}/(\text{Mg}+\text{Fe}^{2+}) > 0.3$; and grunerite with $0.3 > \text{Mg}/(\text{Mg}+\text{Fe}^{2+})$. Asbestiform varieties of these amphiboles are often referred to as “amosite.” Cummingtonite differs from *anthophyllite* in that it possess a monoclinic structure.

cytokine: A protein released from one cell type and that modifies the biological responses of the producing cell (autocrine effect) or those of other cell types (paracrine effect). Cytokines include tumor necrosis factor (TNF), interleukins (e.g., IL-1, IL-2), and transforming growth factors (e.g., TGF- α and TGF- β).

cytotoxic: An adjective to describe any substance that possesses the ability to kill (or to lyse) cells.

dark-field TEM image: An image formed by using an aperture to exclude the central (“undiffracted”) electron beam. Regions that are diffracting into the aperture appear bright, and regions that are not diffracting into the aperture appear dark. See *bright-field TEM image*.

Dauphiné twin: A common type of twin in quartz, resulting from the two possible orientations assumable by tetrahedra during the transition from β -quartz to α -quartz. Parts of the crystal will assume one orientation and other parts will assume the other orientation. See *Brazil twin*.

defect structure: The structures that define the departure of a crystal from its ideal structure. Defect structures do not occur in a long-range ordered fashion. Point defects (e.g., misplaced atoms) and planar defects (e.g., stacking faults) are examples of defect structures.

d_{hkl} : The interplanar spacing (i.e., the length of the vector normal to the planes) for the plane (*hkl*).

diagenesis: Alteration of a rock or mineral resulting from conditions <1 kbar and <100 to 300°C . Diagenesis is analogous to mild metamorphism.

diaspore: α - AlOOH . See *boehmite*.

dickite: A 1:1 layer silicate with an ideal composition of $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$. Dickite is a member of the kaolin group.

dioctahedral sheet: An octahedral sheet in which two thirds of the octahedral sites (cf. trioctahedral sheet) are occupied by a cation.

dioctahedral substitution: The substitution of vacancies in a trioctahedral sheet.

diopside: A pyroxene mineral with an ideal composition of $\text{CaMgSi}_2\text{O}_6$. It is the pyroxene analog of tremolite.

displacive transformation: A phase transition characterized by the bending of chemical bonds but for which no chemical bonds are broken. These transitions occur rapidly and are reversible. See *reconstructive transformation*.

dissolution: The process of releasing solid constituents to a fluid. A mineral is said to dissolve congruently when the release of material to the fluid coincides with the

stoichiometry of the dissolving mineral. During incongruent dissolution, the stoichiometry of the material released to the fluid differs from that of the mineral, so a solid with a different composition (e.g., a leached layer) remains behind.

ditrigonal: A form consisting of six sides with alternate angles of equal magnitude.

dolomite: A carbonate (structurally somewhat similar to calcite) with an ideal composition of $\text{CaMg}(\text{CO}_3)_2$.

dyspnea: Difficult or labored breathing.

EDS: Energy-dispersive spectrometry. The intensity of X-rays emanating from a sample is measured by a detector as a function of energy (i.e., wavelength). All energies of interest are measured simultaneously.

effector cell: A cell that may function by elaborating growth factors or other factors contributing to inflammation of disease. Generally refers to cells of the immune system. *C.f.*, *target cell*.

eicosanoid: See *arachidonic acid*.

enantiomorphic twin: A twin in which one domain is related to the other by a change in handedness, i.e., by reflection across a mirror or inversion through a point.

endothelium: The layer of cells that line the blood and lymph vessels, the heart, and other cavities of the body.

end member: A mineral species that defines one end point of a mineral solid-solution series. Typically, end member refers to a compositional end point. For example, tremolite $[\text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2]$ and ferro-actinolite $[\text{Ca}_2\text{Fe}_5\text{Si}_8\text{O}_{22}(\text{OH})_2]$ are end members of a mineral series with a varying Fe/Mg ratio.

enzyme: An organic catalyst, often a protein secreted by cells. Enzymes catalyze chemical reactions.

eolian: Derived by a process involving the wind, e.g., involving transportation by the wind.

eosinophil: A type of *leukocyte*.

epidemiology: The study of disease in human populations.

epitaxy: The condition where one crystal serves as a template during the growth of another crystal and the resulting mineral pair exhibits specific crystallographic relationships and the boundary is often periodic.

epithelium: The layers of cells and connecting tissues that form the covering of internal and external body surfaces, including the lining of the respiratory tract.

epithelial cell: A type of cell that occurs in an external surface or in the lining of an internal surface. The skin and the surface of the respiratory tract consist of epithelial cells.

equant: Said of a crystal having the same or nearly the same dimensions in all directions. See *asbestiform*, *fibrous*, *prismatic*, *acicular*, *tabular*.

erionite: A fibrous zeolite of ideal composition $\text{K}_2\text{NaCa}_{1.5}\text{Mg}(\text{Al}_8\text{Si}_{28})\text{O}_{72}\cdot 28\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the erionite structure.

Erionite has been implicated as the causative agent in mesotheliomas in non-occupationally-exposed individuals in Turkey, and it has been shown to be cytotoxic, genotoxic, fibrogenic, and carcinogenic in a variety of *in vitro* and *in vivo* assays. See *zeolite*.

erythrocyte: Red blood cell.

etiology: The science dealing with the causes of disease.

euohedral: Said of a mineral grain possessing a morphology defined by its own rational crystal faces.

exsolution: The process whereby a crystal separates into two or more crystalline phases without addition or removal of material.

feldspar: A mineral group with the general formula $K_xNa_yCa_{1-(x+y)}Al_2-(x+y)Si_2+(x+y)O_8$. Feldspar is the most common mineral group at the earth's surface.

Fenton reaction: A generic oxidation/reduction reaction based on the reaction $Fe^{2+} \rightarrow Fe^{3+} + e^-$. The reaction was first proposed by H.J.H. Fenton in 1894 (*J. Chemical Society* 65, 899–910) as a mechanism to oxidize tartaric acid. A similar mechanism was proposed by F. Haber and J. Weiss in 1934 (*Proc. Royal Society London A* 147, 332–351) in the breakdown of hydrogen peroxide. In research on mineral-induced disease, *Fenton reaction* is often used to refer to the Fe-catalyzed oxidation/reduction process resulting in the formation of active oxygen species, and *Haber-Weiss reaction* is sometimes used to refer specifically to the reaction involving the the Fe-catalyzed breakdown of H_2O_2 .

ferritin: The iron-containing protein associated with ferruginous bodies. Originally thought to be a product of red blood cell lysis, ferritin occurs in several different forms, originates from different biological processes, and is generated in several different organs.

ferro-actinolite: An amphibole with ideal composition $Ca_2(Fe^{2+},Mg)_5Si_8O_{22}(OH)_2$. Ferro-actinolite is the iron-rich end member of the Mg– Fe^{2+} series tremolite–ferro-actinolite, with $0.5 > Mg/(Mg+Fe^{2+})$. See *actinolite*, *amphibole*, and *tremolite*.

ferruginous body: Mineral fibers coated with an iron-rich material believed to be derived from ferritin or hemosiderin. Sometimes, ferruginous bodies are described in terms of the mineral forming the core, e.g., *asbestos body* or *zeolite body*.

fiber: Mineralogists have generally applied the term fiber to minerals with a highly elongate morphology developed during growth. However, numerous other definitions have been assumed for the term fiber, including: (1) a 3:1 aspect ratio; (2) being respirable (e.g., less than a critical size so that it can pass through the respiratory tract to the bronchioles and alveolar ducts); (3) being an individual particle of asbestos; and (4) being less than a specific diameter but greater than a specific length [e.g., Stanton et al. (1981, *J. National Cancer Institute* 67, 965) proposed that most carcinogenic fibers are $\leq 0.25 \mu m$ in diameter and $> 8 \mu m$ in length, whereas other workers have suggested other size criteria]. Clearly, the definition for the term fiber is not rigorous, rather it is generally defined operationally.

fibril: An individual fiber of asbestos, generally a single crystal. Often, an asbestos particle consists of numerous fibrils bound together. Chrysotile fibrils are generally ~ 25 nm in diameter with a central tube of ~ 7 nm, but there is much variation in these dimensions.

fibroblast: The primary cell of connective tissue, including in the lung. Fibroblasts secrete molecular collagen that is polymerized to form connective-tissue fibers.

fibrogenic: Possessing the ability to induce fibrosis.

fibrosis: See *pulmonary fibrosis*.

fibrous: In mineralogy, according to Zoltai (1981, *Reviews in Mineralogy* 9A, 237–278), a mineral is said to be fibrous if it “gives the appearance of being composed of fibers, whether the mineral actually contains separable fibers or not.” See *asbestiform*, *acicular*, *prismatic*, *equant*, *tabular*.

flint: A type of microcrystalline quartz.

foci: A concentration of cells that may pile up on one another.

fractional coordinates: The coordinates (designated x , y , and z) that define the position of an atom within the unit cell. The coordinates are defined in terms of fractions of each axis of the coordinate system (i.e., each side of the unit cell).

framework silicate: A mineral class consisting of species with SiO_4^{4-} tetrahedra polymerized in three dimensions, along with other cations. Included in this class are the feldspar minerals and the zeolites. The silica minerals (e.g., quartz, tridymite, cristobalite) are commonly grouped among the silicates for convenience, though they technically are oxides, not silicates.

fraipontite: A 1:1 layer silicate with an ideal composition of $(\text{Zn,Al})_3(\text{Si,Al})_2\text{O}_5(\text{OH})_4$.

fuller's earth: A naturally occurring, fine-grained, earthy material made up of various silicates, chiefly the clay minerals montmorillonite and palygorskite.

gangue mineral: The valueless minerals of an ore, where an ore is a rock containing a mineable metal or mineral.

garnet: A mineral group with the general formula $A_3B_2\text{Si}_4\text{O}_{12}$, where A is typically Ca^{2+} , Mg^{2+} , Fe^{2+} , or Mn^{2+} , and B is typically Al^{3+} , Fe^{3+} , or Cr^{3+} .

genotoxic: Possessing the ability to induce damage to the genetic material (i.e., DNA) of a cell.

gibbsite: $\text{Al}(\text{OH})_3$.

goethite: $\alpha\text{-FeOOH}$. See *lepidocrocite* and *akaganeite*.

granite: An igneous rock containing major amounts of quartz and feldspar and lesser amounts of other minerals.

grossular: A garnet mineral with an ideal composition of $\text{Ca}_3\text{Al}_2\text{Si}_4\text{O}_{12}$.

growth factor: Highly specific proteins in serum that are generally present in very low concentrations but that are necessary for cell growth by stimulating cell division. See *cytokine*.

grunerite: See *cummingtonite*.

habit: The shape or morphology that a crystal or aggregate of crystals assumes during crystallization.

Haber-Weiss reaction: See *Fenton reaction*.

halloysite: A member of the kaolin group of minerals. Halloysite can exhibit tubular, fibrous, and spherical habits.

hematite: A mineral species that is a polymorph of $\text{Fe}_2\text{O}_3 = \alpha\text{-Fe}_2\text{O}_3$. See *maghemite*.

hemolysis: The destruction, alteration, dissolution, or lysis of red blood cells. This results in bursting of the red blood cell to release hemoglobin.

hexagonal symmetry: Sixfold rotational symmetry.

hexagonal system: One of the six crystal systems, characterized by either a threefold or sixfold axis that is perpendicular to three identical axes that intersect at angles of 120° .

histology: Microscopic anatomy, i.e., the study of the structure and chemistry of tissues as related to their functions.

homeostasis: Equilibrium in the body with respect to various functions and the chemical compositions of fluids and tissues.

HRTEM: High-resolution transmission electron microscopy. Typically, modern 100 to 300-keV TEMs have point-to-point resolutions in the range of 1.6 to 3.0 Å, i.e., approximately equivalent to most nearest-neighbor distances in minerals. Hence, these TEMs can produce images of the atomic structure of a material under fortuitous conditions.

hydrologic cycle: The cycling of water between the atmosphere and the earth's surface, either via transpiration or evaporation. The cycle includes the movement of water to the seas.

hydrothermal activity: A metamorphic or igneous process involving heated (up to hundreds of degrees Celsius) water. Typically, this heated fluid interacts with the rocks through which it flows, forming new (often hydrous) minerals.

hydroxyl group: In mineralogy and geochemistry, the term applies to the negatively charged OH (or hydroxide ion), which may be present as an anionic group in a mineral structure or as a dissolved species in a fluid (sometimes functioning as complexing agent). This is distinct from the "hydroxyl radical."

hydroxyl radical: In biology, the term generally applies to the neutrally charged OH^\bullet , which is a highly active free radical capable of damaging other hydrogen-bearing molecules, such as DNA. This is distinct from the "hydroxyl group." The hydroxyl radical is sometimes written as $^\bullet\text{OH}$, to emphasize that the unpaired electron is associated with the oxygen atom.

hyperplasia: An increase in the normal numbers of cells. Hyperplasia often causes an increase in the size of an organ.

IARC: International Agency for Research on Cancer.

ideal composition: The composition typically given for a mineral species. Many minerals, however, exhibit solid solution. So the actual composition of a mineral sample may differ from the ideal composition.

Ig-: A prefix indicating immunoglobulin, e.g., IgA and IgG. See *immunoglobulin*.

IL-: A prefix indicating interleukin-, e.g., IL-1, IL-2, etc. See *interleukin*.

illite: A 2:1 layer silicate with the ideal composition $(K,H_3O)Al_2(Si_3Al)O_{10}(OH)_2$ (as given by Nickel and Nichols, 1991). However, most clay mineralogists agree that illite generally contains a partially unoccupied interlayer site, and a more generalized formula for illite is $A^+_{\frac{1}{x}} Al_2(Si_{4-x}Al_x)O_{10}(OH)_2$, where $x \approx 0.7$ p.f.u. and A^+ is generally K.

immune response: The host response to pathogens. This response may include the activation of cells, an increase in the numbers of specific cells, and a release of substances that can neutralize the pathogen (e.g., active oxygen species) or mediate other aspects of the immune response (e.g., cytokines).

immunoglobulin: One of a class of structurally related proteins. Antibodies are immunoglobulins, and immunoglobulins probably all function as antibodies. Abbreviated *Ig*.

incongruent: See *dissolution*.

index of refraction: The ratio of the velocity of light *in vacuo* to the velocity of light in the material (e.g., crystal).

inflammation: A process characterized by the influx of cells of the immune system into a tissue. These cells release substances that may either exacerbate or mitigate disease. Inflammation is generally a localized response to injury to cells or tissues. The inflammatory process may be acute (ending after a period of time) or chronic (which may lead to the formation of damaged or scarred tissue).

initiation: A heritable change or modification of the DNA of a cell that is an early step in carcinogenesis. See *carcinogenesis*.

inosilicate: See *chain silicate*.

interlayer region: The region between the 2:1 or 1:1 layers in layer silicates. This region is typically either unoccupied or occupied with cations, water, or hydroxide sheets.

interleukin: A group of lymphokines and polypeptide hormones. Lymphokines are released by lymphocytes following contact with a specific antigen, and they help effect cellular immunity by stimulating monocytes and macrophages. See *cytokine*.

Interleukin-1 (IL-1): A protein that can modulate immune and inflammatory responses. IL-1 exists in two forms (α and β), both having a molecular weight of ~ 17 kd.

Interleukin-8 (IL-8): An ~ 6 – 8 -kd protein that is a potent chemoattractant for neutrophilic leukocytes. IL-8 is an important mediator of inflammatory-cell recruitment to sites of tissue injury or infection and is a member of the *Chemokine* cytokine family.

interstitium: A small area or space within an organ or tissue (e.g., the lung).

in vitro: In an artificial environment, e.g., in a test tube or media.

in vivo: In the living body.

ionic strength: A measure of the salinity of an aqueous solution, given by the equation $I = \frac{1}{2} \sum m_i z_i^2$, where I is the ionic strength, m_i and z_i are the molality and charge of each species (i) in the solution.

isomorphous substitutions: Chemical substitutions that occur in a mineral series possessing one structure across the series.

isostructural: Possessing the same structure.

isotropic: In optical microscopy, said of a mineral or material through which light travels the same speed in any direction.

jimthompsonite: A triple-chain silicate with a structure similar to an amphibole but with wider chains. The ideal formula for jimthompsonite is $(\text{Mg,Fe}^{2+})_{10}\text{Si}_{12}\text{O}_{32}(\text{OH})_4$. Jimthompsonite often occurs as defects within magnesium-rich amphiboles, such as anthophyllite or cummingtonite. The monoclinic variety is named clinojimthompsonite.

kaolin: A soft earthy rock that contains major amounts of kaolin group minerals, particularly kaolinite.

kaolin group: A group of 1:1 layer silicates with the general formula $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$. Minerals in this group include kaolinite, dickite, nacrite, and halloysite.

kaolinite: A member of the kaolin group.

kd: Kilodalton. A dalton is equivalent to an atomic mass unit, which is defined as $1/12$ the atomic weight of ^{12}C .

kellyite: A 1:1 layer silicate with an ideal composition of $(\text{Mn,Mg,Al})_3(\text{Si,Al})_2\text{O}_5(\text{OH})_4$.

lavage: A procedure used to harvest cells (and any other easily mobilized material such as particles or fluids) from a specific organ. Lavage can be performed *in situ* (i.e., on a living organism) or on a specific organ removed by excision.

layer silicate: A mineral class consisting of species with SiO_4^{4-} tetrahedra polymerized in two dimensions to form tetrahedral sheets. Included in this class are 1:1 layer silicates (e.g., serpentine, kaolinite), 2:1 layer silicates (e.g., talc, mica), the 2:1:1 layer silicates (e.g., chlorite), and modulated layer silicates (e.g., palygorskite, sepiolite). 1:1 layer silicates have one tetrahedral sheet bonded to one sheet of octahedrally coordinated cations (termed octahedral sheet), and these 1:1 units are stacked atop one another. 2:1 layer silicates have a tetrahedral sheet bonded to each side of the octahedral sheet to form 2:1 units that are stacked atop one another. Modulated layer silicates generally consist of 1:1 or 2:1 units that are discontinuous, forming islands or ribbons of 1:1 or 2:1 structure that are interrupted by regions with complex structures. Examples of modulated layer silicates include *antigorite* and *greenalite* (modulated 1:1 layer silicates) and *palygorskite* and *sepiolite* (modulated 2:1 layer silicates).

leach: To remove constituents selectively from a mineral or rock.

lepidocrocite: $\gamma\text{-FeOOH}$. See *goethite* and *akaganeite*.

lesion: An injury or other change of an organ or tissue of the body which leads to impairment or loss of function.

leukocyte: White blood cell.

leukotriene: See *arachidonic acid*.

lithic: Pertaining to or made of stone or rock.

lizardite: A subgroup name for planar serpentine minerals of ideal composition $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$. The term lizardite can be modified by the suffixes *-IT* and *-2H₁* to identify the crystallographic arrangement of the sheets in the structure. The resulting terms (“lizardite-*IT*” and “lizardite-*2H₁*”) are mineral-species names. See *serpentine*.

lumen: The interior space within a tubular structure, such as a bronchus.

lymphocyte: Lymph cell.

lyse: To kill a cell.

lysosome: An internal vacuole containing enzymes used by a cell to break down a foreign body, such as a bacterium.

macrophage: A cell type that is part of the immune system. Macrophages are types of phagocytes, i.e., they are capable of engulfing (and subsequently transporting or destroying) foreign bodies.

macrophage inflammatory protein 2 (MIP-2): An ~6-kd protein that is chemotactic for neutrophilic leukocytes. MIP-2 is an important mediator of inflammatory-cell recruitment.

maghemite: A mineral species that is a polymorph of Fe_2O_3 . $\gamma\text{-Fe}_2\text{O}_3$. See *hematite*.

magnesio-cummingtonite: See *cummingtonite*.

magnesio-riebeckite: Magnesium end member of the riebeckite series of amphiboles.

magnesite: A carbonate (similar to calcite) with an ideal composition of MgCO_3 .

magnetite: A mineral species in the spinel group with the ideal composition of $(\text{Fe}^{2+}, \text{Mg})\text{Fe}_2^+ \text{O}_4$.

major element: Any element present in major amounts, generally >0.5 wt % for the element's oxide. See *minor element* and *trace element*.

massive: Said of a mineral that is physically isotropic, e.g., lacking a platy, fibrous, asbestiform, or acicular morphology. Massive minerals are commonly polycrystalline.

mast cell: A cell type of the connective tissue.

medium: The solution used to grow cells *in vitro*. Media generally consist of both nutrients and antibiotics to protect the cells from contamination.

mesothelioma: A type of malignant tumor arising from mesothelial cells.

mesothelium: The lining of the lung (*pleural mesothelium*), digestive organs (*peritoneal mesothelium*), or heart (*pericardial mesothelium*). A single layer of mesothelial cells constitutes the mesothelium.

metamorphism: The mineralogical, chemical, and structural adjustment of rocks in response to changes in the original physical and chemical conditions to which the rock equilibrated. Metamorphism is restricted to changes that occur at high pressure and

temperature. Lower temperature processes similar to metamorphism include *diagenesis* and *weathering*.

metastable: Said of a mineral or phase that is under conditions outside of its thermodynamic stability field or of a mineral or phase that has no field of thermodynamic stability.

mica: A group of 2:1 layer silicates with an ideal charge of -1 p.f.u. on the 2:1 layers. This charge is introduced by the substitution of Al for Si in the tetrahedral sheets, and it is compensated by univalent cations (e.g., K and Na) in the 12-coordinated sites within the interlayer region.

microtopography: The morphology of the surface on the scale of the chemical interactions that take place there, usually on the order of 10^{-1} to 10^0 nm.

Miller indices: The indexes h , k , and l used to describe a crystal face. The values for Miller indices are determined by the reciprocals of the intercepts made by the plane on the a-, b-, and c-axes, respectively. Hence, the (100) plane intersects the a-, b-, and c-axes at 1, ∞ , and ∞ . The use of brackets “ $\{h k l\}$ ” indicates a class of faces or planes that are crystallographically equivalent, i.e., they are related by a symmetry operation.

mineral: A naturally occurring inorganic substance possessing a composition that is fixed or that varies within well defined limits and a periodic structure with translational symmetry. A substance that does not possess translational symmetry (i.e., is not crystalline) is sometimes referred to as a mineraloid.

mineral family: The broadest division within the classification scheme for minerals. *Silicates* comprise a mineral family.

mineral group: A sub-division of a mineral family consisting of mineral species with similar structures. *Amphiboles* comprise a mineral group.

mineral series: Two or more mineral species with the same structure but different compositions, such that intermediate compositions can occur. For example, tremolite and ferro-actinolite form a mineral series with a varying Fe:Mg ratio.

mineral species: Analogous to animal and plant species. The most specific distinct division within the classification scheme for minerals. A mineral species name defines a specific structure and specific composition or compositional range. Mineral species are sometimes subdivided into varieties (i.e., crocidolite is a varietal name for asbestiform riebeckite).

minor element: Any element present in minor amounts, generally ~ 0.05 to 0.5 wt % for the element's oxide. See *major element* and *trace element*.

MIP-2: See *macrophage inflammatory protein 2*.

mitosis: Asexual reproduction. Nuclear division resulting in exact duplicates of a cell.

modulated layer silicate: A group of minerals with structure based on a layer-silicate-like structure, where the layers are no longer continuous in two dimensions but form strips or islands. The silicate sheets remain continuous but have nonbridging oxygens pointing in two different directions.

moganite: A metastable polymorph of SiO_2 .

Mohs hardness scale: Hardnesses of minerals are typically reported using the Mohs hardness scale, which ranges from 1 to 10 (softest to hardest). The scale is defined by ten minerals that have been assigned integral hardnesses: talc (with a hardness of 1), gypsum, calcite, fluorite, apatite, orthoclase, quartz, topaz, corundum, and diamond (with a hardness of 10). Other common minerals are used to define the remaining integral hardness values.

monoclinic system: One of the six crystal systems. Monoclinic minerals have unit cells defined by a coordinate system in which one of the axes (the unique axis) is perpendicular to the other two but the remaining two axes need not be orthogonal. Specifically, the monoclinic system is characterized by only a single twofold axis, a single plane of symmetry, or a combination of the two.

monocyte: A mononuclear leukocyte (9 to 12 μm in diameter) that normally constitutes 3 to 8% of the leukocytes in the circulating blood. Monocytes can transform to macrophages.

montmorillonite: A mineral species of the smectite group with the ideal composition $(\text{Na,Ca})_{0.3}(\text{Al,Mg})_2\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the montmorillonite structure. Montmorillonite is a member of the *smectite* group.

mordenite: Species of zeolite with ideal composition $\text{K}_{2.8}\text{Na}_{1.5}\text{Ca}_2(\text{Al}_9\text{Si}_{39})\text{O}_{96} \cdot 29\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the mordenite structure. Thus, this zeolite generally has an Al:Si ratio of ~1:4, although the exact ratio varies between samples and can be chemically manipulated. See *zeolite*. Most natural mordenites are fibrous.

mucociliary escalator: The apparatus responsible for clearing foreign agents from the respiratory tract. Particles, other foreign agents, and cells (e.g., macrophages) can be entrapped in the mucus lining the respiratory tract. This mucus is propelled upward and out of the respiratory tract by the beating action of epithelial cells' cilia. This mucus can then be swallowed or expectorated. For a more detailed discussion, see Chapter 14.

muscovite: A 2:1 layer silicate with an ideal composition of $\text{KAl}_2(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_2$. Muscovite is a member of the mica group.

nacrite: A 1:1 layer silicate with an ideal composition of $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$. Nacrite is a member of the kaolin group.

népouite: A 1:1 layer silicate with an ideal composition of $\text{Ni}_3\text{Si}_2\text{O}_5(\text{OH})_4$.

neoplasm: New and abnormal growth.

neutrophil: A mature white blood cell normally constituting 54 to 65% of the total number of leukocytes.

NMR: Nuclear magnetic resonance.

O_2^- : See superoxide.

octahedral sheet: A polymerized sheet of edge-sharing octahedra. A structural unit common to many hydroxides and layer silicates.

octahedron: A coordination polyhedron characterized by 6 apices and 8 triangular sides. (octahedra, *pl.*)

odinite: A 1:1 layer silicate with an ideal composition of $(\text{Fe,Al})_3(\text{Si,Al})_2\text{O}_5(\text{OH})_4$. Odinite-1M and odinite-1T are the species names.

OH•: See *hydroxyl radical*.

OM: Optical microscopy.

opal: An amorphous or poorly crystalline form of SiO_2 (i.e., a mineraloid). Often opal contains a significant amount of water, so its formula is written as $\text{SiO}_2 \cdot n\text{H}_2\text{O}$, where n is generally <0.5 . There are several varieties of opal (e.g., opal-A and opal-CT) that differ in structure. For example, opal-CT has cristobalite- and tridymite-like aspects to its structure.

opsonin: A substance that enhances phagocytosis. A specific or immune opsonin is an antibody formed in response to a specific antigen, i.e., it has structural components that recognize structural components on the antigen. See *immunoglobulin* and *antibody*.

organelles: Structural components of a cell that are analogous to organs in an animal.

ortho-: A prefix used to connote an orthorhombic structure.

orthorhombic system: One of the six crystal systems. Orthorhombic minerals have unit cells defined by an orthogonal coordinate system but with axes of different lengths.

OSHA: Occupational Safety and Health Administration.

oxide: In mineralogy, the oxides are a family of minerals consisting of oxygen+cations, where the cations are typically metals or alkaline earth cations. Examples include magnetite (Fe_3O_4), hematite ($\alpha\text{-Fe}_2\text{O}_3$), rutile (TiO_2), and corundum ($\alpha\text{-Al}_2\text{O}_3$).

oxygen radicals: See *active oxygen species*.

palygorskite: A mineral species name for a modulated layer silicate with the ideal composition $(\text{Mg,Al})_2\text{Si}_4\text{O}_{10}(\text{OH}) \cdot 4\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the palygorskite structure. Although many non-fibrous palygorskites have been described, Jones and Galan (1988, *Reviews in Mineralogy* 19, 631) suggest that these occurrences are better described as other clays (e.g., illite) and that all palygorskites are fibrous. Other names that have been used to describe palygorskite include attapulgitite, pilolite, and lassalite. The terms mountain leather and mountain wood have also been used to describe palygorskite, although some of these occurrences may refer to sepiolite, chrysotile, or other minerals. See *attapulgitite*, *sepiolite*.

parachrysotile: A serpentine polymorph with a structure similar to chrysotile.

paracrine effect: See *cytokine*.

paragonite: A 2:1 layer silicate with an ideal composition of $\text{NaAl}_2(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_2$. Paragonite is a member of the mica group.

particle: An individual unit constituting a dust or a separable distinct unit in a rock. Particle implies no restrictions with respect to composition, internal structure, shape, or mineral content. However, in a dust, individual particles are frequently monomineralic.

parting: A weak tendency for minerals to fracture along planes. Parting differs from *cleavage* in that it is generally related to the presence of defects (e.g., exsolution lamellae)

within the mineral rather than the crystal structure of the mineral. Parting varies from sample to sample.

pathogen: An agent capable of producing disease.

pathogenesis: The origin and development of disease.

pathology: The study of the nature, causes, and effects of disease.

pecoraite: A 1:1 layer silicate with an ideal composition of $\text{Ni}_3\text{Si}_2\text{O}_5(\text{OH})_4$.

pericardium: The membrane lining the cavity containing the heart. Sometimes called the pericardial sac. The pericardium consist of a layer of connective tissue covered with a layer of mesothelium. The part adjacent to the heart is the epicardium or visceral pericardium.

peritoneum: The membrane lining the cavities containing the stomach, intestines, *etc.* The peritoneum consists of a layer of connective tissue covered with a layer of mesothelium. The part adjacent to the organs is the visceral peritoneum, and the part lining the cavity is the parietal peritoneum.

p.f.u.: per formula unit.

phagocyte: A type of cell capable of internalizing a foreign body via the process called phagocytosis.

phagocytosis: The process of engulfing a foreign body. Typically, a cell (phagocyte) will extend pseudopodia around the foreign body and internalize it in a cavity (phagosome). Once internalized, the cell can secrete various agents in an attempt to destroy the foreign body.

phagosome: The internal vacuole formed during phagocytosis. This vacuole will contain the foreign body targeted by the phagocyte.

phagolysosome: The internal vacuole formed by the merging of a phagosome and a lysosome.

phillipsite: A species of zeolite with ideal composition $\text{K}(\text{Ca}_{0.5}\text{Na})_2(\text{Al}_3\text{Si}_5)\text{O}_{16}\bullet 6\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the mordenite structure.. See *zeolite*. Most natural phillipsites are fibrous.

phlogopite: A 2:1 layer silicate with an ideal composition of $\text{KMg}_3(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_2$. Phlogopite is the magnesium end member of biotite series.

phosphate: A family of minerals with structures containing phosphorus–oxygen tetrahedra.

phospholipase: An enzyme that catalyzes the hydrolysis of a phospholipid.

phospholipid: A lipid containing phosphorus. Phospholipids consitute cell membranes.

phyllosilicate: See *layer silicate*.

plane: See *Miller indices*.

plaque: A deposit of material on a flat surface, such as the epithelium of the lung or pleura.

pleura: The membrane lining the cavities containing the lungs. The pleura consists of a layer of connective tissue covered with a layer of mesothelium. The part covering the lungs is the visceral pleura; the part lining the cavity is the parietal pleura; and the potential space between the visceral and parietal pleura is the pleural cavity or space.

PM10: Particulate matter less than 10 microns in diameter.

PM2.5: Particulate matter less than 2.5 microns in diameter.

pneumoconiosis: In pathology, non-neoplastic reaction of the lung due to the accumulation of inhaled dusts. Some uses of the term include all lung diseases caused by the accumulation of inhaled dusts.

point of zero charge: Points of zero charge are pH values corresponding to specific states of surface charge. The conventional PZC is the pH value at which the net particle charge is zero. The point of zero net proton charge (PZNPC) is the pH value at which the net proton surface charge is zero, and this can be measured by potentiometric titration. A thorough discussion of the distinctions between the various points of zero charge is given by Sposito (1984, *The Surface Chemistry of Soils*, Oxford University Press, New York, 234 p.).

polyanions: Polymerized anionic groups.

polygonal serpentine: A chrysotile-like serpentine mineral consisting of a tube-like crystal with planar serpentine (lizardite) sides.

polyhedron: See *coordination polyhedron*.

polymorph: Polymorph is a term applied to materials with the same composition but with different structures.

polymerized: Said of molecular groups (e.g., coordination polyhedra) that share common apices, edges, or faces with adjacent molecular groups. For example, a SiO_4^{4-} tetrahedron can share three of its oxygens with adjacent SiO_4^{4-} tetrahedra (and so on) to form a polymerized sheet.

polysomatic series: A series of structures made from differing proportions or arrangements of a pair of polysomatic slabs or modules. For example, pyroxene–amphibole–triple-chain-silicate (e.g., jimthompsonite)–mica form a polysomatic series of P (pyroxene) and M (mica) modules: (P)–(MP)–(MMP)–(M).

polysome: In cell biology, a cluster of ribosomes active in protein synthesis.

polysome: In mineralogy, modular structures constructed from slabs of less complex structures. For example, the amphibole structure can be represented by slabs of pyroxene structure (P slabs) alternating with slabs of mica structure (M slabs). Thus, the amphibole structure is a polysome that can be denoted by ...MPMPMP... or (MP).

polytype: A structure formed by ordered stacking of essentially identical layers in a specific sequence. Polytype is a subset of polymorph.

prismatic: A term used to describe crystals exhibiting aspect ratios >1 and having parallel sides. *Glossary of Geology* offers no restrictions on the aspect ratio; however, Skinner et al. (1988, *Asbestos and Other Fibrous Materials*, Oxford Univ. Press, New York) suggest that prismatic crystals have aspect ratios in the range 1–3. See *asbestiform, fibrous, acicular, equant, tabular*.

prograde metamorphism: Metamorphism that results from increasing the pressure and temperature such that the minerals which crystallized under lower pressures and temperatures are no longer stable, and the rock recrystallizes to other minerals.

progression: See *carcinogenesis*.

proliferation: The sequence of events leading to DNA synthesis and mitosis; the process of cell replication or division.

promotion: A necessary series of steps in tumor development characterized by increased proliferation (cell division) of initiated cells. See *carcinogenesis*.

prostaglandin: See *arachidonic acid*.

protein: Macromolecules consisting of long sequences of amino acids.

protolith: The original rock from which a metamorphic rock developed during metamorphism.

pulmonary fibrosis: A lung disease characterized by increased deposition of collagen and other proteins in the lung. The fibroblast is the primary cell type affected.

PVPNO: polyvinyl-2-pyridine *N*-oxide. A polymer capable of bonding to negatively charged sites. PVPNO has been shown to decrease the bioactivity of negatively charged surfaces, such as quartz and the edges of kaolinite crystals, ostensibly by blocking the “dangling” Si–O bonds at the surface. A detailed discussion of PVPNO is presented in Nolan et al. (1981, *Environmental Research* 26, 503–520.).

pyriboles: A term used to describe any *pyroxene* or *amphibole*. These minerals can be difficult to distinguish in hand sample, so *pyribole* was a term introduced by field geologists to categorize these occurrences until identification could be made in the laboratory. Biotite (a 2:1 layer silicate) can sometimes be confused with *pyriboles* in hand sample, so the term *biopyribole* is sometimes used to indicate the *pyriboles* plus micas and talc.

pyrophyllite: A mineral species that is a 2:1 layer silicate with the ideal composition $\text{Al}_2\text{Si}_4\text{O}_{10}(\text{OH})_2$.

pyroxenes: A mineral group of chain silicates possessing a single-chain structure with an ideal composition of BCT_2O_6 . The pyroxene M1 site (designated C in the formula) is octahedrally coordinated; commonly contains Mg and/or Fe^{2+} (but can contain elements such as Al, Fe^{3+} , and Mn); and is analogous to the amphibole M2 site. The pyroxene M2 site (designated B in the formula) is 6-, 7-, or 8-coordinated; can contain Mg, Fe^{2+} , Ca, or Na; and is analogous to the amphibole M4 site. The T-site is tetrahedrally coordinated and generally contains Si but can also accommodate Al.

pyroxenoids: A mineral group of chain silicates possessing a single-chain structure. The pyroxenoids differ from the pyroxenes in that their silicate chains possess a different topology. Generally, the chains in pyroxenoids are kinked relative to the linear pyroxene chains. Pyroxenes and pyroxenoids can be treated as a polysomatic series between true pyroxene and wollastonite (a pyroxenoid with an ideal composition of CaSiO_3). The topologies of the remaining pyroxenoids can be constructed by assembling P and W slabs.

PZC: Point of zero charge. See *point of zero charge*.

PZNPC: Point of zero net proton charge. See *point of zero charge*.

quartz: A member of the silica group. At temperatures below $\sim 573^{\circ}\text{C}$, all “quartz” is low quartz or α -quartz.

RBC: Red blood cell.

reconstructive transformation: A phase transformation characterized by the breaking of chemical bonds. These transitions occur slowly and are simply irreversible. Often, the activation energy associated with breaking bonds and reorganizing the structure is so large that a mineral may exist outside of its stability field, i.e., it may exist metastably. See *displacive transition*.

refractive index: See *index of refraction*.

relative risk: The ratio of the rate of disease in one population compared to a reference population.

respirable: Said of any agent able to pass through the respiratory tract. Generally, in man particles must be smaller than about $10\ \mu\text{m}$ in length and about $3\ \mu\text{m}$ in diameter to be respirable. However, in other species, these figures are different. For example, in rats, the particles must be less than about $5\ \mu\text{m}$ in length and about $1\ \mu\text{m}$ in diameter.

retrograde metamorphism: Metamorphism that results from decreasing the pressure and temperature such that the minerals which crystallized under higher pressures and temperatures are no longer stable and the rock recrystallizes to other minerals.

richterite: A species of amphibole with ideal composition $\text{Na}_2\text{Ca}(\text{Fe},\text{Mg})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$.

riebeckite: An amphibole with ideal composition $\text{Na}_2(\text{Fe}^{2+},\text{Mg})_3\text{Fe}_2^{3+}\text{Si}_8\text{O}_{22}(\text{OH})_2$. The asbestiform variety of this amphibole is often referred to as “crocidolite.”

Rietveld analysis: A method for analyzing powder diffraction data to extract various parameters, including abundances of minerals, mineral lattice parameters, atomic coordinates, and other structural information about the minerals present in a sample. Typically, Rietveld analysis is applied to X-ray or neutron powder diffraction data.

rock: Generally an aggregate of one or more minerals, e.g., granite, limestone, sandstone.

rotational symmetry: The property possessed by structures that are identical when rotated through an angle about an axis. The degree of the rotational symmetry describes the number of such operations possible in 360° . For example, the letter “N” has 2-fold rotational symmetry, since a 180° rotation reproduces the letter and two 180° rotations are possible in 360° .

rutile: A mineral species that is a polymorph of TiO_2 .

SAED: See *selected-area electron diffraction*.

SAM: Scanning Auger electron microscopy.

SEM: Scanning electron microscopy or scanning electron microscope. Sometimes SEM is used to refer to secondary electron microscopy, one of the techniques done with a scanning electron microscope.

selected-area electron diffraction: An electron diffraction technique that utilizes an aperture on the image plane of the objective lens to select a specific area of the image from which to

form a diffraction pattern. The minimum unique area that can be selected for diffraction is $\sim 0.5 \mu\text{m}$, because, even if smaller apertures are used, this represents the approximate minimum area from which diffracted beams will originate.

sepiolite: A mineral species name for a modulated layer silicate with the ideal composition $\text{Mg}_4\text{Si}_6\text{O}_{15}(\text{OH})_2 \cdot 6\text{H}_2\text{O}$, where the “•” indicates that the water molecules are not integral to the sepiolite structure. Although many non-fibrous sepiolites have been described, Jones and Galan (1988, *Reviews in Mineralogy* 19, 631) suggest that these occurrences are better described as other clays (e.g., illite) and that all sepiolites are fibrous. Other names that have been used to describe sepiolite include parasepiolite, gunnbjarnite, xylotile, falcondoite, Meerscham, Myrsen, and Ecume de Mer. See *palygorskite*.

sericite: A petrological term generally applied to fine-grained muscovite or paragonite.

serpentine: A mineral group of 1:1 layer silicates with a general formula of $(\text{Mg}, \text{Al}, \text{Fe}, \text{Mn}, \text{Ni}, \text{Zn})_{2-3}(\text{Si}, \text{Al}, \text{Fe})_2\text{O}_5(\text{OH})_4$. Also used to denote the subgroup consisting of the Mg 1:1 layer silicates lizardite, chrysotile, and antigorite.

serpentinite: A green rock consisting dominantly of serpentine minerals. Serpentinites generally form by the alteration of pyroxene- and olivine-bearing rocks.

sheet silicate: See layer silicate.

silanol group: The functional group SiOH.

silica: A chemical term for silicon dioxide, SiO_2 . Also a term for material consisting of SiO_2 , e.g., quartz and silica glass.

silicate: A family of minerals with structures containing silicon–oxygen polyhedra plus other cations (e.g., Mg, Ca, and Na). Typically, these polyhedra are tetrahedra, and they can be isolated or polymerized to one, two, or three other tetrahedra by sharing of their oxygen atoms.

silicosis: A nonmalignant disease of the lung caused by inhalation of dust containing silica minerals. Not all silica minerals may cause silicosis.

smectite: A mineral group of 2:1 layer silicates with the general formula $(\text{Ca}, \text{Na}, \text{Li})_{0-1}(\text{Mg}, \text{Fe}, \text{Al}, \text{Li}, \text{Ni}, \text{Cr}, \text{Zn})_{2-3}(\text{Si}, \text{Al})_4\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$. Smectites possess interlayer cations that can be easily exchanged with cations in a solution.

solid solution: substitutional, interstitial, and omission...

space group: The group of symmetry operations (e.g., rotation, reflection, translation) that can be performed on a crystalline structure and leave the arrangement of atoms in the structure unchanged. There are 230 possible space groups.

specific gravity: Specific gravity is a unitless measure of density and is equivalent to the ratio between the density of a substance relative to the density of water at 4°C (i.e., the maximum density of water). Specific gravity is often determined by comparing the weight of a material in air with the weight of a material in water; hence, it is sometimes defined as the ratio of a material's weight to the weight of an equivalent volume of water.

squamous: Scaly or scale-like. A layer of flattened cells lining or covering the surface of organs such as the skin or esophagus. The lining of the bronchus may change its state of differentiation from epithelial to squamous cells in response to irritants such as cigarette.

stacking fault: A type of planar defect in crystalline materials in which two adjacent planes are stacked differently relative to each other than the other planes in the material are stacked.

stishovite: A very high-pressure polymorph of SiO₂, containing 6-coordinated Si.

STM: Scanning tunneling microscopy or scanning tunneling microscope.

stoichiometry: The numerical relationship between elements in a reaction or formula.

stuffed derivative: A group of minerals with frameworks isostructural with one of the silica polymorphs but with Al and cations substituted for Si and vacancies. For example, eucryptite (LiAlSiO₄) is a stuffed derivative of quartz (SiO₂ or □SiSiO₄); the two minerals have frameworks with the same structure and are related by the substitution □+Si → Li+Al.

substitution: The exchange a different atom or vacancy for an atom or vacancy in a crystal structure (e.g., the exchange of Al for Si in the tetrahedral sites of a silicate).

superoxide: An active oxygen species with the general formula of O₂⁻.

superstructure: A structure with a longer-range periodicity than the dominant periodicity, or substructure. For example, the dominant periodicity in the 2:1 layer silicates is ~10 Å normal to the sheets; however, some 2:1 layer silicates have an additional periodicity that repeats every two 2:1 layers, i.e., they have a superstructure normal to the 2:1 layers. When the superstructure repeats at an integral multiple of the dominant periodicity, the superstructure is said to be commensurate. Incommensurate super-structures do not repeat at an integral frequency of the dominant periodicity. Diffraction maxima arising from a superstructure are generally weaker than those arising from the substructure.

synergistic: The characteristic of two or more substances acting together to produce an effect greater than the additive effects of the individual substances.

tabular: Said of a crystal form that has one dimension markedly smaller than the other two. See *asbestiform*, *fibrous*, *prismatic*, *equant*, *acicular*.

talc: A mineral species that is a 2:1 layer silicate with the ideal composition Mg₃Si₄O₁₀(OH)₂.

target cell: A cell that may be affected in disease.

tectosilicate: See framework silicate.

TEM: Transmission electron microscopy or transmission electron microscope.

tetrahedral sheet: A polymerized sheet of tetrahedra. A structural unit common to the layer silicates.

tetrahedron: A coordination polyhedron characterized by four apices and four triangular sides. (tetrahedra, *pl.*)

TGF-β: Transforming growth factor β. TGF-β is a *cytokine*, and it potentiates or inhibits (depending on the cell type) the response of most cells to other growth factors. TGF-β also regulates the differentiation of some cell types.

titania: A chemical term for titanium dioxide, TiO₂.

TNF- α : Tumor necrosis factor α or cachectin. A 17-kilodalton (kd) protein (a cytokine) produced by a variety of phagocytic and nonphagocytic cell types including: macrophages, monocytes, polymorphonuclear leukocytes, lymphocytes, smooth muscle cells, and mast cells. TNF- α has the ability to lyse tumor cells *in vitro*.

torr: A measure of pressure (or vacuum), where 1 torr = $1/760$ atmosphere \approx 1 mmHg.

toxicology: The study of toxic substances (or poisons).

trace element: Any element present in minute amounts, generally $< \sim 0.05$ wt % for the element's oxide. See *major element*

translocation: The process that transports a particle from its site of deposition (e.g., in the lung) to another site, such as the pleura.

tremolite: A species of amphibole with the ideal composition $\text{Ca}_2(\text{Mg}, \text{Fe}^{2+})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$. Tremolite is the magnesium-rich end member of the Mg- Fe^{2+} series tremolite-ferro-actinolite, with $\text{Mg}/(\text{Mg} + \text{Fe}^{2+}) \geq 0.9$. See *actinolite*, *ferro-actinolite* and *amphibole*.

triclinic: One of the six crystal systems. Triclinic minerals have unit cells that have a onefold axis of symmetry.

tridymite: A high-temperature polymorph of SiO_2 .

trigonal symmetry: Threefold rotational symmetry.

trioctahedral sheet: An octahedral sheet in which all unique (i.e., 3 out of 3) octahedral sites are occupied by a cation.

trioctahedral substitution: The substitution of cations into the otherwise unoccupied sites in a dioctahedral sheet.

tumor: The pathologic term for a mass, usually used to describe a neoplasm. New and abnormal growth. Tumors may be benign (i.e., will not metastasize or invade adjacent tissue) or malignant.

tumorigenic: Possessing the ability to induce a tumor.

twinning: The property of minerals to intergrow rationally with one or more units of the same mineral and where the two units are related in a mathematically described manner (i.e., by a symmetry operator).

unit cell: A subunit of a structure possessing translational periodicity. The entire crystal structure can be described by repeating the unit cell along the translation directions.

vacancy: An unoccupied crystallographic site.

vacuole: A membrane-bound cavity within a cell.

vermiculite: A mineral group of 2:1 layer silicates with the general formula $(\text{Mg}, \text{Fe}, \text{Al})_3(\text{Si}, \text{Al})_4\text{O}_{10}(\text{OH})_2 \cdot 4\text{H}_2\text{O}$.

viability: Capability of living.

vug: A small cavity in a rock, usually lined with crystals.

weathering: The mineralogical and chemical adjustment of a rock or mineral in response to interactions with atmospheric agents. Most weathering occurs at or near the earth's surface and includes processes such as the hydration of minerals stable at higher temperatures and pressures to form clay minerals and other soil constituents.

winchite: An amphibole with the ideal composition $\text{NaCa}(\text{Mg,Fe}^{2+})_5(\text{Si,Al})_8\text{O}_{22}(\text{OH})_2$.

XAS: X-ray absorption spectroscopy.

XPS: X-ray photoelectron spectroscopy.

XRD: X-ray diffraction.

X-ray diffraction: A series of techniques that exploit the ability of crystalline substances to diffract X-rays. X-ray diffraction (XRD) techniques include methods for analyzing individual crystals or powders. The diffracted X-rays contain information about the types and arrangements of atoms with each crystal structure and the abundances of each mineral species present. See *Rietveld Analysis*.

zeolite: A mineral group.

zeta potential: A measure of the potential energy difference between a bulk solution and the boundary between the free solvent and the solvent adhering to the fiber surface. Zeta (ζ) potential is proportional to the total surface potential.

ZPC: Zero-point-of-charge. Equivalent to point of zero charge, or PZC. See *point of zero charge*.