Appendix C: Glossary of Terms

STRUCTURAL GEOLOGY and map interpretation employ a large number of technical terms, some of which have been introduced in this book. These basic terms, used in the present text, are compiled into a glossary of terms for quick reference. Definitions are in accordance with common usage but are formulated in a concise fashion that may ease understanding for novices in the field. Neither attempts nor claims should be made that the below definitions could be used to settle arguments or differences in the variety of descriptions available from existing dictionaries or other sources.

Active remote sensing. A system based on the illumination of a scene by artificial radiation and the collection of the reflected energy returned to the system, such as used in radar and laser systems.

Albedo. The ratio of the reflected and incident electromagnetic radiation for a specific material surface.

Alluvium. Unconsolidated sediment deposited by a stream.

Amplitude. Half the crest-to-trough height of a wave; half the distance from the crest of an anticline to the trough of an adjacent syncline, measured parallel to the axial plane.

Analogue image. An image, where the continuous variation in the property being sensed is represented by a continuous variation in tone or color; alternative to the technique of digital images.

Angular fold. A fold having an angular hinge or hinges and plane or nearly plane limbs.

Angular perspective. Block diagram with two vanishing points on a horizontal horizon line.

Angular unconformity. Angular relationship that exists in rocks, where a sequence has been deposited and later tilted, followed by erosion (or nondeposition) and then renewed deposition.

Anticline. Normally an upward closing fold that contains older rocks in the core.

Antiform. Fold that closes upward. In contrast to the term anticline, the term antiform bears no restriction on the age distribution of the folded sequence.

Antiformal syncline. Concave-downward fold, wherein layering dips away from the axis, but the rocks in the

center are younger; also, called downward-facing syncline.

Antithetic normal fault. Normal fault that dips oppositely to join a larger normal fault.

Apex. The point representing the hinge in any cross section.

Apparent dip. The angle that a structural surface makes with the horizontal, measured in any random, vertical section, rather than perpendicular to the strike. It varies from zero to the true dip, depending on whether the section is taken close to the direction of strike or dip.

Apparent thickness. Thickness of a rock unit measured normal to its subparallel boundaries in an arbitrary cut. It is usually larger than the true thickness, which appears only if cut at right angles to the boundaries of rock layers and dikes.

Aquiclude. An impermeable bed that hinders or prevents ground water movement.

Aquifer. Rock or sediment through which ground water moves easily.

Ash, volcanic. Uncemented pyroclastic material, consisting of fragments mostly under 4 mm. in diameter. Two grades are commonly distinguished: coarse ash, 0.25-4.0 mm. in diameter; fine ash, less than 0.25 mm. in diameter.

Ashfall. A rain of ash from an eruption cloud.

Ashflow. An avalanche, consisting of volcanic ash and gases, highly heated, traveling down the flanks of a volcano. See, also, nuée ardente.

Asthenosphere. A zone within the Earth, some tens of kilometers below the surface and of undefined thickness. It is a zone of weakness, where plastic movements occur.

Astrobleme. Structure produced by extraterrestrial impact, frequently consisting of concentrically and radially arranged horsts and grabens about a central chaotic zone. See impact structure.

Asymmetric fold. Fold having one limb shorter than the other.

Aulacogen. Tectonic trough on a craton, bounded by convergent normal faults. They are thought to be failed rift-arms.

Axial culmination. The highest point of a dome, anticlinal crest, or synclinal trough.

Axial plane or surface. The locus of the hinges of all beds (surfaces) forming the fold. Axial plane is used in several somewhat different ways, including a plane that intersects the crest or trough in such a manner that the limbs or sides of the fold are more or less symmetrically arranged with reference to it.

Axial trace. The line formed by the intersection of the axial surface with any other surface or plane (commonly the ground).

Axis of fold. The line which, moved parallel to itself, generates the folded surface.

Azimuth. Direction of a horizontal line as the angle on an imaginary horizontal circle, measured clockwise away from the geographic north.

Base map. Topographic map, aerial photograph, satellite image, or existing geological map on which additional geological information is plotted for a specific purpose.

Basement. Rock units below a sedimentary cover, separated from them by an angular unconformity or nonconformity. Although shallow basement rock may be simply folded sedimentary rocks, more commonly the basement consists of igneous and metamorphic rocks.

Basin. A circular, down-folded structure.

Batholith. A large mass of igneous rock, that formed when magma was emplaced at depth, crystallized, and was subsequently exposed by erosion.

Bedding. Primary layering in sediments and sedimentary and some volcanic rocks.

Bedding plane. A nearly flat surface separating two beds of sedimentary rock. Each bedding plane marks the end of one deposit and the beginning of another, having different characteristics.

Benioff zone. The zone of inclined seismic activity that extends from a trench downward into the asthenosphere.

Bit. An abbreviation of *binary digit*, which refers to an exponent of ground number 2, used to represent data in basic computer languages.

Black smoker. Submarine hydrothermal spring, located on mid-oceanic ridges that emanate hot water and steam, satured with sulfides that color the water black.

Block diagram. A drawing of the Earth's crust depicting a three-dimensional perspective, showing geologic and topographic features. The top of the block gives a bird's-eye view of the ground surface, and its vertical sides show the structure of the subsurface in cross-section.

Bombs, volcanic. Fragments of lava, which were liquid or plastic at the time of ejection, but which acquired a distinctive shape or surface markings while flying through the air or at the time of landing.

Brittle deformation. Discontinuous deformation.

Byte. A group of eight bits of digital data in binary form. One byte can represent 256 digital numbers, used in ASCI codes. It is, also, used to code digital images with digital numbers between 0 and 255.

Cabinet perspective. Three-dimensional perspective, commonly isometric, using cabinet-like surfaces to portray geological subsurface structures.

Caldera. A gigantic basin with steep walls at the summit of a volcano; larger than a crater and usually formed by collapse.

Cauldron subsidence. Commonly cylindrical block, subsided into a magma chamber along a steep ring fracture, usually associated with ring dikes.

Chevron fold. Fold with straight limbs and sharp angular hinge.

Cinder cone. A steep, conical hill, formed by the accumulation of cinders and other loose material, expelled from a volcanic vent by escaping gases.

Cleavage (of rocks). The tendency of rock to split along parallel, closely spaced surfaces. These surfaces are often highly inclined to the bedding planes in the rock.

Closed fold. Fold in which the limbs make an interlimb angle of 70° to 30°.

Closure (of a fold). In an anticline, a dome, or a swell, the vertical height between the highest point on a given surface and the lowest horizontal plane, which gives a closed trace for that surface.

Collision zone. Zone of concentrated deformation at the leading edge of convergent lithospheric plates.

Columnar joints. Joints forming a pattern of polygons in the plane normal to the joints, resulting in a system of columns with polygonal bases.

Columnar section. A vertical section of a sequence of rock units with thickness drawn to scale and lithologies indicated by conventional symbols, supplemented with brief notes on age and fossil content.

Competent. A term applied to a bed or group of beds, which, during folding, is able to lift not only its own weight but that of the overlying beds without appreciable internal flowage.

Composite cone. A volcano composed of both lava flows and pyroclastic material.

Concentric folds. Parallel folds in which folded surfaces define circular arcs and maintain the same center of curvature.

Cone sheets. Thin sheets of intrusive (dikelike) material, dipping centrically inward toward the source of the magma. They are usually associated with ring dikes.

Congruous folds. Folds which conform with each other in attitude of the axial surface and hinge.

Conical folds. Noncylindrical folds with convergent axes.

Conjugate folds. Two sets of related folds, whose axial surfaces are inclined toward one another.

Context. The known geological features of a particular area or characteristics of a particular feature seen on a remote-sensing image.

Continental crust. The solid outer layers of the Earth, including granitic rocks of the continent.

Continental drift. The original theory that explained the present positions of the continents and ocean basins by the breakup and dispersion of a single great continent, called Pangea.

Contour lines. Lines that connect points of equal elevation on a curved surface above or below a reference datum (e.g., sea level), projected orthographically on a reference plane, usually a map.

Contrast stretching. Expanding a measured range of digital numbers in an image to a larger range to enhance the contrast of the components in the image.

Convection currents. Movements of material due to differences in density, generally the result of heating.

Convergent plate boundary. A boundary between two lithospheric plates that are moving toward each other; manifested at the surface as oceanic trenches or as continent-continent collision sutures.

Core (of the Earth). The central zone of the Earth with a radius of about 3,480 km.

Core (of a fold). The inner part of a fold; the part located nearest to the axial surface.

Coulisse diagram. Perspective diagram, consisting of a sequence of spaced serial sections, commonly arranged in isometric projection to enhance the illusion of a three-dimensional perspective view.

Cover (of basement). Sedimentary beds separated from the underlying basement by an unconformity.

Crater. A bowl- or funnel-shaped depression, generally in the top of a volcanic cone; often the major vent of volcanic products. See, also, impact crater.

Creep. The slow, downhill movement of soil and regolith.

Crest (of a fold). The highest point in a given surface on an anticline in a given cross-section.

Crest line. The line connecting the highest points on a fold in an infinite number of cross-sections.

Cross-cutting. A principle of relative dating. A rock or fault is younger than any rock (or fault) through which it cuts.

Cross-section. Illustration of the subsurface structure, usually in a vertical cut.

Crust. The outermost layer of the Earth, that overlies the mantle above the Mohorovicic discontinuity. It consists of continental crust of mainly granodioritic composition and oceanic crust of mainly basaltic composition.

Crystalline rock. A hard rock, composed of interlocking crystals; often of igneous origin.

Cylindrical fold. Fold that can be generated by moving the fold axis parallel to itself.

Data plane. A term used in GIS to refer to different kinds of spatially distributed data that can be represented by a map or an image and that can be displayed or analyzed together with other kinds of spatial data.

Debris avalanche. Glowing or sliding, wet or dry mixture of soil and rock debris, that moves at high speed.

Debris slide. A slide involving downslope movement of relatively dry, unconsolidated regolith and rock debris. The mass does not exhibit backward rotation, as in a slump, but slides or rolls forward.

Deformation. The process that results in a change in the shape or size of a body by particle displacement within the body.

Deformation patterns (structure). A rock pattern that has resulted from deformation.

Depocenter. Center of deposition on a subsiding surface, commonly located between buoyant salt domes.

Detachment fault. A fault marking a surface along which a layer or sheet has been detached and displaced.

Dextral strike-slip fault. See right-lateral strike slip fault.

Diapir. The mobile core of a fold, such as salt or magma, which has injected the more brittle overlying rocks.

Diatreme. A breccia-filled volcanic pipe, thought to have formed by a gaseous explosion.

Digital image. An image composed of pixel elements. Each pixel is toned according to the value of its digital number. The property being measured by the digital number has been converted from a continuous range of analog values to a range expressed by a finite number of integers, recorded as a binary code from 0 to 255 in one byte.

Digital number (DN). Integer value between 0 and 255, expressed as a binary integer in one byte. It provides the value for each pixel in digital images.

Dike. A sheet-like body of intrusive igneous rock, that cuts across the layering of the host rock.

Dike swarm. Extensive set of parallel dikes that are evidence of an extensional crustal regime at the time of emplacement.

Dip. Angle made by an inclined geological surface with the horizontal measured perpendicular to strike.

Dip-slip. The component of slip along the fault dip.

Dip-slip fault. A fault whose net-slip is approximately parallel to the dip of the fault.

Dip-slip movement. Movement down or up, parallel to the direction of a fault.

Disconformity. An unconformity between two sets of parallel strata, that marks an interval of erosion or nondeposition.

Discordant. A term used to describe plutons that cut across existing rock structures, such as bedding planes.

Disharmonic folding. Contrasting fold wavelengths in a sequence of folded layers; may lead to décollement.

Disharmonic fold. Fold that changes shape from layer to layer; involves moderate to high ductility contrast.

Displacement. Total amount of motion measured parallel to the movement direction; amount of relative motion measured on opposite sides of a fault; net-slip.

Divergent plate boundary. Boundary between two lithospheric plates that move apart to create a new, oceanic-type lithosphere along a rift; appears at the surface as rifts and crests of active oceanic ridges.

Dome. An upwarp, or other convex-upward structure, circular or elliptical in map pattern, whose outer boundaries dip away from a center in all directions.

Dome-and-basin pattern. Fold pattern, consisting of systematically related domes and basins; may be produced by two generations of folds that overprint each other at right angles.

Dormant volcano. A volcano that is not presently erupting but is considered likely to do so in the future.

Double-vanishing point perspective. See angular perspective.

Doubly-plunging fold. A fold, either an antiform or a synform, that reverses its direction of plunge within the observed area.

Down-dip. A direction that is downward and parallel to the dip of the structure.

Drift. The general term for any glacial deposit.

Drumlin. A streamlined symmetrical hill composed of glacial till. The steep side of the hill faces the direction from which the ice advanced.

Ductile-brittle transition. Transition from brittle behavior in the upper crust to ductile behavior in the lower crust, where brittle behavior is inhibited because strain softening occurs as a result of increases in temperature and pressure with depth.

Ductile deformation. Permanent, irreversible deformation, occurring by plastic or crystalline creep of solid rock without loss of cohesion.

Dynamics. The study of strain in terms of the stress fields which caused it.

Earthflow. The downslope movement of water-saturated, clay-rich sediment. Most characteristic of humid regions.

Earthquake. Vibration of the Earth, produced by the rapid release of energy.

Elastic deformation. Nonpermanent deformation in which rock returns to its original shape when the stress is released.

End moraine. A ridge of till, marking a former position of the front of a glacier.

Endogenic. Formed by process originating within planetary interiors.

En-echelon. An overlapping or staggered arrangement in a zone of geologic structures, that are oriented obliquely to the trend of the zone as a whole. The individual structures, e.g., fractures of folds, are short, compared to the length of the zone.

En-echelon folds. Parallel folds that are offset, as are the edges of shingles on a roof when viewed from the side.

Enveloping surface. Surface constructed by connecting the crests or troughs of small folds on a larger fold by a surface tangent to the small folds.

Eruption. Ejection of volcanic materials (lava, gases, pyroclastics) onto a planetary surface, either from a central vent or from a fissure system.

Esker. Sinuous ridge, composed largely of sand and gravel, deposited by a stream, flowing in a tunnel beneath a glacier near its terminus.

Exaggerated dip. Apparent dip resulting when the vertical scale in a cross-section is exaggerated.

Exaggerated thickness. Apparent thickness resulting when the vertical scale in a cross-section is exaggerated.

Exaggeration factor. Ratio of the vertical and horizontal length scales of cross-sections.

Exogenic. Formed by processes that originate at or near the surface of the Earth, sometimes due to extraterrestrial influences (e.g., meteoritic impacts).

Extension. Ratio of the new and original lengths, minus unity.

Extensional fault. Fault in which bedding undergoes layer-parallel extension.

Extinct volcano. A volcano that is not erupting and is not expected to do so in the future; a dead volcano.

Extrusive. Igneous activity that occurs at the Earth's surface.

Failure. The fracture or rupture of a rock or other material, that has been stressed beyond its ultimate strength.

False-color image. A color image, where parts of the non-visible electromagnetic spectrum are expressed as one or more of the red, green, and blue components, so that the colors seen on the image do not represent real colors of the imaged object; only variations in parts of the electromagnetic spectrum are portrayed by the color pattern.

Fault. A fracture or a zone of fractures in rock, along which displacement of the sides relative to one another, parallel to the fracture, has taken place.

Fault gouge. A non-cohesive fault rock, consisting largely of a clay-like paste.

Fault scarp. A line of relatively straight, steep slopes or steps in topography, indicating a vertical component of displacement by faulting.

Fault separation. See separation.

Fault slip. Amount of displacement, measured in the direction of movement on the fault surface proper.

Fault trace. The trace of a fault on the surface of the Earth or on any specified surface (e.g., map or cross-section).

Fault zone. A zone of sheared, crushed, or foliated rock, along which numerous small displacements have taken place, adding up to an appreciable total offset of the undeformed walls.

Fenster. An exposure of the rock beneath a thrust sheet or recumbent fold, produced where erosion has locally truncated the overlying rock units. The exposure is completely surrounded by units on the thrust sheet in a perfectly developed fenster.

Fissility. The property of splitting easily into thin layers along closely spaced, parallel surfaces, such as bedding planes in shale.

Fissure. A fracture with a component of displacement normal to the fracture surface. The resulting opening is commonly filled with vein material.

Fissure eruption. An eruption in which lava or pyroclastic material issues from a narrow fissure or a group of fissures.

Flood basalts. Term applied to those basaltic lavas which occur in essentially horizontal position over vast areas, such as the Columbia River Plateau. They are the product of fissure eruptions.

Flow. A type of movement common to mass-wasting processes, in which water-saturated material moves down-slope as a viscous fluid.

Fold. A bent layer or series of layers that were originally horizontal and subsequently deformed.

Fold axis. Axial line of a fold that separates dip in one direction from dip in the opposite direction.

Fold crest. The line which joins the highest points of successive vertical cross-sections of a fold, as defined by any particular folded surface.

Fold pattern. Structure on maps or sections, consisting of curved layers due to deformation. Some maps show contorted layers, due to the effects of topography cutting into homoclinal, nonfolded layers.

Fold trough. The axial line in a synform, that joins the lowest points of the fold, as defined by a particular bed.

Foliation. Layering in deformed and metamorphosed rocks, imparted by the parallel orientation of platy or

elongate minerals. Schistosity, gneissic banding, slaty cleavage, and crenulation cleavage are all foliations.

Foot wall. The lower wall of an inclined fault.

Form lines (form-line contours). Lines - commonly strike lines - on a map, that outline the trend and shape of a structure.

Fracture. A surface, along which loss of cohesion has taken place in a solid.

Frequency. The number of waves passing through a reference point per unit of time.

Fumarole. A vent from which fumes or vapors issue.

Gentle fold. Fold with an interlimb angle of 180° to 120°.

Geographic grid. A system of parallels and meridians used to locate points on the Earth's surface.

Geographic Information System (GIS). An organizational system of data handling and analysis, based on sets of spatial data. The data sets are geographically referenced and are commonly implied to be in digital format, either in vector- or raster-format.

Geological map. A map on which is recorded geologic information, such as the distribution, nature, and age relationships of rock units, structural symbols and features (folds and faults), mineral deposits, and fossil localities.

Geological record. History of the Earth, Moon, and planets, as inferred from studies of geological evidence, preserved in bedrock of their accessible crusts.

Geology. The science that examines the Earth and, increasingly, also, its neighboring planetary bodies, their form and composition, and the changes that they have undergone and are undergoing.

Geothermal energy. Energy derived from the internal heat of the Earth.

Geothermal gradient. The change in temperature of the Earth with depth.

Geyser. A hot spring from which a column of hot water and steam is explosively discharged at intervals.

Glacier. A thick mass of ice, originating on land from the compaction and recrystallization of snow, that shows evidence of past or present flow.

Gneiss dome. Structural dome in metamorphic terrane cored by foliated gneiss, commonly surrounded by concordantly foliated metamorphic rocks or supracrustals.

Gneissosity. Coarse texture by a fabric of oriented mineral grains and bands of alternating mineralogical composition comprising light-colored silicic and dark-colored mafic layers.

Gondwana. The southern continents that remained coherent when Pangea broke up into two supercontinents: Gondwana and Laurasia. Gondwana included: South America, Africa, Australia, India, and Antarctica.

Graben. A linear topographic depression, due to subsidence along a system of nearly parallel normal faults.

Greenstone belts (terrains). Belts within Precambrian shileds that are characterized by the occurrence of abundant compact dark-green metamorphosed basic igneous rock (e.g., basalt, gabbro, diabase, spilite), that owes its color to the presence of chlorite, actinolite or epidote. The greenstone belts may contain one or more volcano-sedimentary sequences, each of which typically trends from mafic to felsic volcanism.

Ground moraine. An undulating layer of till, deposited as the ice front retreats.

Half-graben. Block bounded by a normal fault on one side. The other side passes into a gently bending fold.

Hanging wall. Rock mass resting on (above) a fault plane; the upper wall of an inclined fault.

Harmonic fold. A fold whose form is constant throughout its constituent strata.

Herring-bone pattern. Pattern of alternating structural rows of structural contours or form lines, each row in a reverse direction from the adjacent one. Within each row lines are subparallel. The rows are separated by the trace of the axial surface of folds.

Hinge point or **zone.** Part of a fold that has the greatest curvature.

Hinge line. Line where layering changes orientation from dip in one direction to dip in the opposite direction across the crest or trough of a fold.

Historical geology. A major division of geology that deals with the origin of the Earth and its development through time. Involves the study of fossils.

Homocline or **homoclinal.** Structure with uniform dip of bedding in one direction.

Horst. A relatively raised block, due to relative uplift between two oppositely dipping normal faults.

Horizontal fold. Non-lunging fold.

Hot-spot. A volcanic center, derived from a persistently rising plume of hot mantle material.

Hot-spot volcanoes. Volcanoes related to a persistent heat source in the mantle.

Hydrostatic pressure. The pressure exerted by the weight of water at higher levels.

Igneous rock. Rock formed from the crystallization of magma.

Igneous sheets. Tabular body, commonly discordant with the country rock, composed of igneous rock.

Ignimbrite. Ashflow deposit.

Impact breccia. A rock formed when angular fragments and dust are welded together by the heat generated by the impact of a meteoroid.

Impact crater or **impact structure.** Crater formed on a surface by the impact of a projectile, commonly of extraterrestrial origin (e.g., meteorite, asteroid, comet). Kilometer or larger-scale structure, commonly made up of a complex of radial and concentric faults, that have a circular or elliptical outline but are not obviously related to tectonic processes. See, also, astrobleme.

Inclined fold. A fold whose axial surface is inclined from the vertical and in which one limb may be steeper than the other but not overturned.

Inclusion. A piece of one rock unit contained within another. Inclusions are used in relative dating. The rock mass adjacent to the one containing the inclusion must have been there first in order to provide the fragment.

Incompetent. An adjective, indicating the relatively lower ductility of a layer in a sequence of layers with contrasting ductilities.

Inflection point. Point of minimum curvature on a fold surface.

Infrastructure. The highly mobile, deep tectonic level in the crust, where granitic material is generated.

Inlier. Erosionally exposed rock mass, surrounded laterally by the unit above it and with a normal or unconformable contact with the unit below.

Inselberg. An isolated mountain remnant, characteristic of the late stage of erosion in a mountainous, arid region.

Interlimb angle. Angle between the limbs of a fold.

International date line. The longitudinal line on the Earth's surface that closely follows the 180° meridian and is taken as the line along which the calendar day begins.

Intrusion. An igneous rock body, formed when molten igneous rock forces its way into surrounding host rocks and then cools; also, the process of forming such an igneous rock body.

Intrusive rock. Igneous rock that formed below the Earth's surface.

Island arc. A curving chain of volcanic islands, formed at a compressional plate boundary. Volcanic islands are bordered on one side by a deep sea trench.

Isochore. Line on a map through points of equal thickness for a specified subsurface rock unit.

Isoclinal fold. Fold in which the axial surface and limbs are parallel.

Isometric block diagram. Three-dimensional perspective projection with parallel directions scaled commensurate with each other.

Isopach. A line on a map through points of equal true thickness of a specific stratigraphic unit or group of units.

Isostasy. The approximate equilibrium of the crustal blocks. The less the mean specific gravity of a crustal block, the higher it will stand.

Joint. A fracture in rock, along which there has been no movement.

Kame. A steep-sided hill, composed of sand and gravel, originating when sediment collected in openings in stagnant glacial ice.

Kame terrace. A narrow, terrace-like mass of stratified drift, deposited between a glacier and an adjacent valley wall.

Karst. A topography consisting of numerous depressions, called sinkholes.

Kettle hole. Depression created when a block of ice becomes lodged in glacial deposits, leaving an imprint after melting.

Kimberlite. Porphyritic alkalic peridotite with phenocrysts of olivine and phlogopite in a fine ground mass of calcite, olivine phlogopite, and accessory minerals, first described at Kimberley, South Africa.

Kimberlite pipe. A vertical, pipe-shaped intrusion of unusual igneous rocks, that commonly contain diamonds.

Kink band. A tabular zone, normally mesoscopic, in which foliation is deflected along kinks in the foliation.

Kink fold. A chevron-type fold, formed by kinking thin, even layers in schistose rocks, causing sharp deflections along tabular zones.

Klippe. An isolated allochthonous unit, overlying a tectonic surface, surrounded in map pattern by tectonically lower rocks. These are small erosional outliers (remnants) of a thrust sheet.

Laccolith. A massive igneous body intruded between pre-existing strata.

Lahar. Mudflows on the slopes of volcanoes, that result when unstable layers of ash and debris become saturated and flow downslope, usually following stream channels.

Laminar flow. Flow without turbulence, in which the fluid elements follow paths that are relatively straight and parallel to the channel walls.

Landslide. The rapid slide of a mass of rock downslope along planes of weakness.

Lateral moraine. A ridge of till along the sides of a valley glacier, composed primarily of debris that fell to the glacier from the valley walls.

Lattitude. Angular distance of a point on the Earth's surface north or south of the equator, measured along a meridian of the geographic grid.

Lava. Magma or molten rock that has reached the surface or its resulting solid rock after cooling.

Lava dome. A bulbous mass associated with an old-age volcano, produced when thick lava is slowly squeezed from the vent. Lava domes may act as plugs to deflect subsequent gaseous eruptions.

Law of cross-cutting relationships. A body of rock is older than structures or igneous bodies that cut through it. See, also, law of igneous cross-cutting relationships and law of structural relationships.

Law of faunal succession. Fossil organisms in a sequence are more advanced toward the top of the sequence.

Law of igneous cross-cutting relationships. An igneous body must be younger than the rocks it intrudes.

Law of original horizontality. Bedding planes within sediments or sedimentary rocks form in a horizontal to nearly horizontal orientation at the time of deposition.

Law of structural relationships. A structure, such as a fold or fault, must be younger that the rocks it deforms or cuts through.

Law of superposition. Within a layered sequence, commonly sedimentary rocks, the oldest rocks will occur at the base of the sequence and successively younger rocks will occur toward the top, unless the sequence has been inverted through tectonic activity.

Layer-parallel shortening. Deformation, resulting in shortening of a layered sequence parallel to the layering. Pressure solution is a common mechanism.

Left-lateral strike-slip fault. Strike-slip fault, where the left side has moved toward an observer looking along the fault; also, called sinistral strike-slip fault.

Limb (of a fold). The portion of a folded surface located between two adjacent hinges. If the two limbs are not of equal length, they may be called the short limb and the long limb.

Linear vent. A vent formed by a long fissure, reaching the surface (in contrast to a single crater).

Liquefaction. The transformation of a stable soil into a fluid, that is often unable to support buildings or other structures.

Listric fault. Thrust or normal fault with concave-up geometry. These faults have steep dip near the surface but flatten with depth and usually have a curved strike and a spoon-shaped fault surface.

Lithosphere. The solid portion of the Earth, as contrasted with the atmosphere and the hydrosphere.

Lithostatic pressure. The pressure in the crust of the Earth, due to the weight of the overlying rocks.

Longitude. Angular distance of a point on the Earth's surface, measured along latitude lines of the geographic grid toward the east or west relative to an arbitrary reference meridian. Commonly the one through Greenwich, UK, is taken to be 0°.

Longitudinal fault. A fault that is parallel to the trend of the geological structure.

Longitudinal fracture. A fracture plane, which is oriented parallel to the general structural trend of a region.

Maar. A relatively shallow, flat-floored explosion crater, the walls of which consist largely of loose fragments of the country (surrounding) rock.

Magma. Molten rock material with dissolved gases, that forms igneous rocks on cooling. Magma that reaches the surface is called lava.

Magma chamber. An underground reservoir in the Earth's crust, filled with magma, from which volcanic materials are derived.

Magma mixing. The process of altering the composition of a magma through the mixing of material from another magma body.

Magmatic belt. Tectonic province or belt of igneous rock.

Magmatic differentiation. The process of generating more than one rock type from a single magma.

Magmatic episode. Period of intensified magmatic activity in a particular tectonic province.

Magmatic fractionation. The process of successive separation of magma from already solidified phases.

Magmatic stoping. A process of igneous intrusion, whereby a magma gradually eats its way upward by breaking off blocks of the country (surrounding) rock.

Mantle. The zone of the Earth below the crust and above the core (to a depth of 3480 kilometers).

Mantled gneiss-dome. Dome in metamorphic terranes that has a core of foliated gneiss and is surrounded by a conformably foliated cover of metamorphic rocks.

Map symbols. Symbols and signs used on geological maps to indicate lithological distributions, trends, and structures.

Mass wasting. The downslope movement of rock, regolith, and soil under the direct influence of gravity.

Medial moraine. A ridge of till, formed when lateral moraines from two coalescing alpine glaciers join.

Melt. The liquid portion of magma, excluding the solid crystals.

Metamorphic rock. Rock formed by the alteration of pre-existing rock deep within the Earth (but still in the solid state) by heat, pressure, and or chemically active fluids.

Meteorite. Any portion of a meteoroid that survives its traverse through the Earth's atmosphere and strikes the surface.

Meteoroid. Any small solid particle that has an orbit in the solar system.

Mid-ocean ridge. A continuous mountainous ridge on the floor of all the major ocean basins and varying in width from 500 to 5000 kilometers (300 to 3,000 miles). The rifts at the crests of these ridges represent divergent plate boundaries.

Migmatite. A rock exhibiting both igneous and metamorphic rock characteristics. Such rocks may form when light-colored silicate minerals melt and then crystallize, while the dark silicate minerals remain solid.

Minor fold. A small-scale subsidiary fold, usually associated with or related to a major fold.

Mohorovicic discontinuity. The seismic discontinuity, that marks the base of the crust of the Earth.

Monocline. Structure in which otherwise uniformly, gently dipping or horizontal strata are locally steepened.

Mudflow. A flowing mixture of water-saturated mud and debris, that moves downslope under the force of gravity.

Multispectral scanner (MSS). A line scanner that simultaneously records image data from a scene in several different wavebands. It is most commonly applied to the four-channel system with 79-meter resolution, carried by the Landsat series of satellites.

Nappe. A thrust sheet or (less commonly) a large recumbent fold.

Neck. A vertical, pipelike intrusion, that represents a former volcanic vent; usually used to describe an erosional remnant.

Nested granites. Collection of closely spaced granite plutons.

Net-slip. The distance measured on the fault surface between two formerly adjacent points, situated on the opposite walls of the fault. It is the shortest distance, measured in the fault plane, between the two formerly adjacent points.

Nonconformity. Unconformity in which igneous or metamorphic rocks - or both - occur below the erosion surface and sedimentary rocks occur above.

Non-cylindrical folds. Folds in which axes are not consistently mutually parallel, as is required for cylindrical folds.

Normal fault. Dip-slip fault in which the hanging wall has moved down relative to the foot wall.

North-arrow. Arrow used on maps to indicate the direction of the geographical north.

Nose (of a fold). A sharp bend in an outcrop pattern, where a plunging fold intersects the topographic surface.

Nuée ardente. A French term applied to a highly heated (incandescent) mass of gas-charged ash, which is expelled with explosive force and rushes down the mountainside with hurricane speed.

Oblique-slip fault. A fault having both vertical and horizontal movement.

Oblique-slip motion. Combined dip-slip and strike-slip motion on a fault surface.

Oceanic crust. The Earth's crust, where it underlies the oceans, without the granite layer that forms continents.

Oil trap. A geologic structure that allows for significant amounts of oil and gas to accumulate.

Onlap. Progressive pinching out of stratigraphic units, in which the boundary of each overlying unit is transgressed farther over the underlying layers.

Onlier. See outlier.

Open folds. Folds in which the limbs dip gently away from or toward one another, producing a large interlimb angle (>70°).

Ophiolite. A group of mafic and ultramafic igneous rocks, that originated as oceanic crust, but is now exposed along continental sutures after the collision of tectonic plates.

Ore. Usually a useful metallic mineral, that can be mined at a profit. The term is, also, applied to certain nonmetallic minerals such as fluorite and sulfur.

Orogen. A mountain belt. The term is applied to major zones of crustal deformation, characterized by folding, thrusting, and uplift.

Orogeny or **orogenesis.** The processes that collectively result in the formation of mountains. It occurs by terrane accretion and plate collision and is commonly accompanied by folding, faulting, metamorphism, and plutonism.

Outcrop. Area over which a rock body intersects the topographic surface of the Earth. It refers to both exposed bedrock and bedrock covered by superficial deposits.

Outcrop pattern. Pattern of bedrock units as it appears at the surface of the Earth.

Outlier. Isolated outcrop of younger rocks, entirely surrounded by older rocks.

Overthrust. See thrust.

Overturned fold. A fold in which the beds on one limb are upside down.

Pangea. The proposed supercontinent, which 200 million years ago began to break apart and form the present land masses.

Parallel fold. A fold in which the thickness of the folded layers remains contant and in which successive folded surfaces remain mutually parallel throughout.

Parallel perspective. Block diagram with one vanishing point.

Parasitic cone. A volcanic cone that forms on the flank of a larger volcano.

Parasitic fold. A smaller fold on a larger fold.

Partial melt. The stage of melting of rock when it is partly liquid rock and partly solid crystals.

Partial melting. The process by which most igneous rocks melt. Since individual minerals have different melting points, most igneous rocks melt over a temperature range of a few hundred degrees. If the liquid is squeezed out after some melting has occurred, a melt with a higher silica content results.

Passive margin. An inactive continental margin, that is characterized by a thick accumulation of undeformed sediments and sedimentary rocks.

Passive remote sensing. The capture of images, representing the reflection or emission of electromagnetic radiation that has a natural source. It is alternative to active remote sensing.

Pegmatite. A very coarse-grained igneous rock (typically granite), commonly found as a dike associated with a large mass of plutonic rock, that has smaller crystals. Crystallization in a water-rich environment is believed to be responsible for the very large crystals.

Physical geology. A major division of geology, that examines the materials of the earth and seeks to understand the processes and forces acting beneath and upon the Earth's surface.

Pillow lava. Interconnected, sack-like bodies of lava, formed under water.

Pitch. The angle between a line in a plane and a horizontal line measured in that plane.

Pixel. A single sample of data in a digital image, having both a spatial and spectral value. Together the pixels in a digital image portray the spatial variation in the intensity of particular spectral values, monitored by a remote sensing device.

Placer. Deposit formed when heavy minerals are mechanically concentrated by currents, most commonly streams and waves. Placers are sources of gold, tin, platinum, diamonds, and other valuable minerals.

Plastic deformation. Permanent deformation that results in a change in size and shape through folding or flowing.

Plate. One of numerous rigid sections of the lithosphere, that moves as a unit over the material of the asthenosphere.

Plate boundary. Zone of seismic and tectonic activity between adjoining lithospheric plates.

Plate tectonics. The theory that the Earth's crust is broken into individual plates, that slowly move about the surface.

Plug. Vertical, pipe-like body of solidified magma, that represents the conduit of a former volcanic vent.

Plume. A rising column of magma from deep in the mantle, responsible for hot-spot volcanoes; sometimes refers to ash or fume cloud.

Plunge. The vertical angle between a line in space and the horizontal measured along its trend in the downplunge direction.

Plunging fold. Fold with nonhorizontal axis.

Pluton. A body of igneous rock, formed beneath the surface by consolidation of magma.

Pore pressure. Pressure of liquid or gas in rock pores onto the walls of those pores.

Principal point. The center of an aerial photograph.

Profile. Cross-section of the subsurface, commonly drawn perpendicular to the trend of rock structures.

Pseudotachylite. Dark vitreous rock that resembles igneous tachylites but is produced by local shear heating on longer or shorter fault strands within the host rock.

Ptygmatic fold. Near-parallel fold, formed by folding of strong layers in a much more ductile matrix.

Pyroclastic flow. Masses of hot, dry rock fragments, mixed with hot gases; moves away from a volcano at high speeds. See, also, nuée ardente.

Pyroclastics. Solid fragments, formed by explosion or spraying from a volcanic vent; includes ash, cinders, and blocks.

Radar. Acronym for *radio detection and ranging*, which uses pulses of artificial electromagnetic radiation in the 1mm to 1 m wavelength range to locate objects, which reflect the radiation. The position of the object is a function of time taken to reach and return to the antenna.

Rarefaction. Permanent ground distortion, caused by seismic shock or meteoritic impact.

Raster format. A means of representing spatial data in a grid of digital numbers, each line of which can be used to modulate the lines of a video raster.

Reclined fold. Fold that has a moderately plunging hinge and gently dipping axial surface.

Recumbent fold. An overturned fold with a more or less horizontal axial surface.

Reverse fault. Fault with moderate to steep dip (45° or more) in which the hanging wall has moved up relative to the foot wall; mechanically the same as a thrust fault.

Reversed limb. The forelimb of a fold that has been rotated or tilted beyond the vertical so that the sequence of strata appears reversed.

Rift. A long, narrow, topographic depression or graben of regional or global extent, bounded by roughly parallel striking normal faults; often associated with seismic and volcanic activity, due to extension in the lithosphere under this zone.

Rift arm. A long, narrow, continental trough, that is bounded by normal faults, resulting from crustal extension, localized in the rift.

Rift zones. Fissures along which repeated eruptions occur. They usually radiate from the summit of a volcano.

Right-lateral strike-slip fault. Steeply dipping fault, where the right side has moved toward an observer looking parallel to the trace of the fault; also, called dextral strike-slip fault.

Ring complex. A complex system of igneous intrusions, mainly dikes of circular and radial outcrop patterns.

Ring dikes. Concentric dikes, dipping at a small angle from a vertical, either toward or away from a common center, and normally hundreds of meters thick. They form by the intrusion of magma along concentric fractures, formed by the subsidence of a roughly cylindrical mass of roof rock into a magma chamber.

Saddle reef. The separation between layers over the crest of some folds, formed by buckling. The zone may be filled with secondary mineralization.

Saddle reef deposit. Mineral deposit, formed in a void along a fold hinge, where strong layers have separated; often found in successive hinges of the same fold.

Salt dome. A dome or plug-shaped salt diapir, circular or elliptical in plan, formed as a result of density contrast between a source salt bed and the overlying country rock.

Scale bar. A horizontal bar on maps and sections with a length corresponding to a specified length in nature.

Sea floor spreading. The mechanism by which new seafloor crust is created at oceanic ridges and slowly spreads away on the separating plates.

Section line. Particular line indicated on geological and geographic maps, along which a cross-section has been constructed to show the subsurface structure.

Sedimentary rock. Rock formed from the weathered products of pre-existing rocks, that have been transported, deposited, and lithified.

Separation. Amount of apparent offset of a faulted surface, measured in a specified direction; may be described as strike-separation, dip-separation, or net separation.

Shatter cone. A distinctively striated conical fragment of rock up to several meters long, along which fracturing occurred by shock waves, generated in a meteoritic impact.

Shear zone. A tabular zone of localized deformation in rock, that has been deformed by relative shearing movement of the wall rock.

Sheeted dikes. A large group of nearly parallel dikes.

Shield. A large, relatively flat expanse of ancient metamorphic rock within the stable continental interior.

Shield volcano. A broad, gently sloping volcanic cone in the shape of a flattened dome, built by overlapping flows of very fluid basaltic lava, e.g., Mauna Loa.

Sill. A tabular igneous body, that was intruded parallel to the layering of pre-existing rock.

Similar fold. Fold that maintains the same shape and curvature throughout a section normal to the hinge. Layer thickness, measured parallel to the axial surface, remains constant.

Single-vanishing point perspective. Block diagram with one vanishing point.

Sinistral strike-slip fault. See left-lateral strike-slip fault.

Sinkhole. A depression produced in a region where soluble rock has been removed by ground water.

Site investigation. Study of rock properties and stability of geological structures at a specific locality in preparation for the design of an engineering structure.

Slide. A movement common to mass-wasting processes, in which the material moving downslope remains fairly coherent and moves along a well-defined surface.

Slump. The downward slipping of a mass of rock or unconsolidated material, moving as a unit along a curved surface.

Sole thrust. The lowest, flat-lying thrust surface, underlying an imbricate zone.

Solfatara. A volcanic vent from which only gases are emitted.

Somma. A ridge or rim, representing the remnant of an ancient caldera wall.

Spatter cone. A small mound above an igneous vent.

Splay. Smaller fault that forms by branching of a larger fault.

Spreading ridge. Topographic ridge, often mid-oceanic, at which seafloor spreading occurs.

Stalactite. An icicle-like structure that hangs from the ceiling of a cavern.

Stalagmite. A column-like form that grows upward from the floor of a cavern.

Stick-slip movement. Intermittent movement along a fault; produced by unstable frictional sliding.

Stock. A large, igneous intrusion, roughly circular in a horizontal plane.

Strata. Parallel layers of sedimentary rock.

Stratigraphic succession. A chronological sequence of sedimentary rocks without any intersection or geological unconformity.

Stratosphere. The layer of the atmosphere above the troposphere. The height of the base of the stratosphere varies from about nine kilometers at the poles to sixteen kilometers at the equator.

Strato-volcano. A volcanic cone, usually of large size, built of alternating layers of lava and pyroclastic material; also, known as a composite cone.

Stress. The intensity of force per unit area on a plane in a body.

Strike. Compass direction of the intersection between a geological surface or plane and a horizontal plane.

Strike-slip. The component of slip along the fault strike.

Strike-slip fault. Fault in which movement is parallel to the strike of the fault plane.

Structural analysis. Description and interpretation of structures on all scales in an area. This involves the observation, description, analysis, and interpretation of the kinds and orientations of folds and other linear structures, foliations and other planar structures, strain and displacement indicators, and faults.

Structural geology. The study of the structural features of rocks, the geographical distribution of these features, and their causes.

Structure contour. A contour line on a geological surface. It represents the strike at any point.

Structure-contour diagram. A perspective diagram that uses elevated structure contours to create the illusion of a three-dimensional view of a particular reference surface.

Structure-contour map. Map that portrays subsurface configurations of a specific reference surface by means of structure contours.

Subduction. The process by which the lithosphere or portions of the lithosphere move downward into the mantle.

Subvolcanic complex. A set of geological features, including ring dikes, cone sheets, and other igneous features, associated with volcanic activity.

Superposed fold. A fold that overprints another, older fold.

Superstructure. The tectonic level in which deformation is predominantly brittle.

Symmetrical fold. A fold whose axial surface is a plane of symmetry (i.e., a fold whose limbs make equal angles with the axial surface). The limbs dip at the same angle on either side of the hinge. Isoclinal folds and elasticas, like other folds, may, also, be symmetrical.

Syncline. A fold that normally closes upward with a core of stratigraphically younger beds.

Synform. A fold that closes downward.

Synformal anticline. A fold in which layering dips inward, as in a syncline, but the rocks in the center of the structure are older, rather than younger; also, called upward-facing anticline.

Synthetic fault. A set of normal faults that tend to enhance crustal flexure. The rotation of the fault blocks is in the same sense as that of the external shear that produced them.

Tectonic outlier. See klippe.

Tectonic window. An isloated outcrop of a tectonic unit, surrounded in map pattern by tectonically higher rocks.

Tectonics. The science of the regional structural and deformational features of the Earth's crust and the movements and forces which have produced them.

Tephra. A collective term for all clastic volcanic material, including ash, cinders, bombs, etc.

Terminal moraine. The end-moraine, marking the farthest advance of a glacier.

Terrain. Refers to a topographic or geographic landscape configuration, for example, a hilly terrain or a wooded terrain.

Terrane. A crustal block bounded by faults, whose geologic history is distinct from the histories of adjoining crustal blocks.

Thematic mapper (TM). A digital-imaging device, carried by Landsat, which records scenes in seven wavebands, six in the visible and near-infrared parts of the electromagnetic spectrum with a resolution of 30 meters, and one in the mid-infrared with a resolution of 20 meters.

Thermal gradient. The rate of change of temperature with distance or depth.

Three-point problem. The determination of the strike and dip of a geological surface, using three points of known elevation and fixed geographic position.

Throw. Vertical component of fault displacement.

Thrust or **thrust fault.** A fault with a low angle of dip (30° or less), in which the hanging wall has moved over the foot wall. Thrust faults are produced by compression. In an overthrust the upper unit is assumed to have been the predominantly active unit; in an underthrust the lower unit is assumed to have been the predominantly active unit.

Thrust sheet. The rock unit, overlying a thrust surface.

Tight fold. A fold in which the limbs dip steeply toward or away from one another.

Tilting. A continuous crustal displacement, resulting in differential changes in elevation.

Topography. General configuration and shape of the land surface, graphically delineated on topographic maps with elevation contours.

Transform fault. A strike-slip fault, produced by differences in motion between plates and within the same plate along spreading ridges. These faults compensate for relative motion between lithospheric plates; kinds include ridge-ridge, ridge-arc, arc-arc, and intracontinental transforms.

Transform plate boundary. A boundary between two lithosphere plates, along which relative displacement is strike-slip.

Transverse fault. A fault that cuts across the trend of the geological structure.

Trap rock. A term applied to dark-colored rocks of dikes, sills, and lava flows.

Trench (oceanic). A long, narrow depression in the deep sea bed, extending at least 2,000 meters below the adjacent sea floor, oriented normally parallel and adjacent to a continental margin or island arc; associated with subduction zones.

Trend. The bearing (direction) of a linear structure.

Triple junction. A point or small area, where three lithospheric plates meet.

Trough. Lowest point in a synclinal or synformal fold.

True dip. The real dip of a structural surface, seen in isometrically scaled sections normal to strike.

True thickness. The real thickness of a layer or dike, seen in isometrically scaled sections normal to strike.

Tsunami. A sea wave, produced by a submarine earthquake or a volcanic eruption.

Tuff. A rock composed of compacted volcanic fragments, generally smaller than 4 mm. in diameter.

Unconformity. Break in the stratigraphic sequence, where some portion of geologic history is missing; produced by nondeposition, erosion, or both, resulting in a loss of strata for part of the geologic record.

Upright fold. A fold with a vertical (or near vertical) axial surface.

Vector format. The expression of points, lines, and areas on a digital map, using Cartesian coordinates for direction and values.

Vein. A mineral deposit, precipitated in a rock fracture.

Vent. An opening at the Earth's surface through which volcanic materials issue forth.

Vertical thickness. Thickness, measured in vertical boreholes, that will be larger than the true thickness if layers are tilted.

Viscosity. A measure of resistance to flow in a liquid. Water has a low viscosity, while honey has a high viscosity.

Volcanic arc. Mountains formed in part by igneous activity, associated with the subduction of oceanic lithosphere beneath a continent. Examples include the Andes and the Cascades.

Volcanic bomb. A streamlined pyroclastic fragment, ejected from a volcano while still semimolten.

Volcanic dome. A steep-sided mass of viscous lava, forming a more or less dome-shaped mass over the volcanic vent.

Volcanic neck. An isolated, steep-sided, erosional remnant, consisting of lava that once occupied the vent of a volcano.

Volcanic pipe. A volcanic vent, filled with consolidated volcanic rock.

Volcanic vent. A pipe-shaped opening, through which products of volcanism can reach the surface.

Volcanogenic. Formed by processes directly connected with volcanism.

V-rule (for outcrop patterns). The outcrop of a formation that crosses a valley forms an acute angle (a "V"), that points in the direction in which the formation underlies the stream, commonly downdip.

V-rule (for topographic contours). Where elevation contours cross a valley, they form an acute angle, that always points upstream.

Wavelength. The mean distance between maxima or minima of a periodic pattern.

Welded tuff. A fine-grained volcanic rock, in which the particles were so hot when deposited that they fused together.

Well. An opening bored into the zone of saturation.

Xenolith. A rock fragment that is foreign to the igneous rock in which it occurs; an inclusion.

Zonation. Condition of being arranged or formed in zones of distinctive nature.

Zoned plutons. Plutons with internal zonation of mineralogical composition, reflecting magmatic differentiation, segregation, and interaction with the country rock.