INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY

IRIS

Glossary
of earthquake-related terms

With links to relevant **IRIS** **Animations** and **Videos**

This Vocabulary list was created to address animations, videos, demos, lessons, software, and more on topics that range from simple faults, to seismic waves, to focal mechanisms found in **IRIS's InClass** pages.

InClass "Search" categories:

▼ Resource Type

- ☐ Animation
- ☐ Demo
- ☐ Lesson
- ☐ Fact-Sheet
- ☐ Poster
- ☐ Software-Web-App
- ☐ Video
- ☐ Interactive
- ☐ Course

▼ Resource Level

- ☐ Novice
- ☐ Intermediate
- ☐ Advanced

▼ Concepts

- ☐ Deformation & Faults
- ☐ Earth's Interior
- ☐ Earthquakes: Hazards
- ☐ Earthquakes in the Earth System
- ☐ Earthquakes: Locating & Describing
- ☐ Earthquakes: Mechanics
- ☐ Earthquakes: Notable
- ☐ Exploration Seismology
- ☐ Forensic Seismology
- ☐ Geographic Region
- ☐ Physics Concepts (related to earthquakes)
- ☐ Plate Tectonics
- ☐ Recording Earthquakes
- ☐ Seismic waves
- ☐ Tsunami
- ☐ Volcanoes

Version 2/21/21

Recursos en español?

Many of the IRIS resources have been translated into Spanish.
Visit the IRIS InClass Search page and select **Language** > **Spanish**, or link here:
http://www.iris.edu/hq/inclass/search#language=2

IRIS animations in **Italian**:
https://www.iris.edu/hq/inclass/search#type=1/language=4

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Glossary of earthquake & tectonics words and concepts

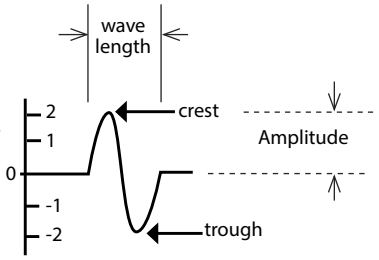
Definitions are drawn chiefly from ***usgs.gov; nasa.gov;*** *and* ***fema.gov)***

Blue are *hot* links to animations or videos that address the topic.

Acceleration—the velocity change in going from one speed to another during a unit of time. For example, when you push on the gas pedal in the car the car goes faster (acceleration). Pushing the brake pedal slows the car (deceleration). During an earthquake when the ground moves, it experiences acceleration. The ***peak ground acceleration*** is the largest increase in velocity recorded by a particular station during an earthquake. See *Peak Acceleration*.

Accelerometer— an electromechanical device that will measure ***acceleration*** forces**.** Used in ***seismographs***.

Aftershock—earthquakes that follow the largest shock (see ***Mainshock***) of an earthquake sequence. They are smaller than the mainshock and within 1-2 rupture lengths distance from the mainshock. Aftershocks can continue over a period of weeks, months, or years. In general, the larger the mainshock, the larger and more numerous the aftershocks, and the longer they will continue. See also ***Foreshock.***



Amplitude—the maximum disturbance or distance from a constant point. On a seismogram, the horizontal timeline is flat until there is a ground disturbance, which is recorded as a wave. The amplitude of a seismic wave is the amount the ground moves up or down. Amplitude is one-half the distance between the crest and trough of one wavelength.

Amplification—increase in size or ***amplitude. S***haking levels at a site may be amplified, by focusing of seismic energy caused by the geometry of the sediment velocity structure, such as basin subsurface topography, or by surface topography. Softer sediment can amplify seismic waves.

Anticline—upward-curving (convex) fold in rock that resembles an arch. When eroded, the central part contains the oldest section of rock. See ***Fold*** and ***Syncline***.

Aseismic—describes a fault on which no earthquakes have been observed.

Asperity—literally "roughness. It is a type of surface roughness appearing along the interface of 2 faults that is stuck or locked. (Physics: the elastically compressed region of contact between two surfaces caused by the normal force.)

Asthenosphere—the ductile part of the earth just below the ***lithosphere*** is about 180 km thick and is found 100–250 km (60–150 mi) below the Earth's surface. The asthenosphere yields to persistent stresses more than the rigid crust or the core.

Attenuation—decrease in wave size, or ***amplitude,*** away from source. When you throw a pebble in a pond, it makes waves on the surface that move out from the place where the pebble entered the water. The waves are largest where they are formed and get smaller as they move away. Seismic waves attenuated away from the earthquake source. USGS animation.

Benioff Zone—dipping planar (flat) zone of earthquakes that is produced by the interaction of a down-going oceanic crustal plate with a continental plate. These earthquakes can be produced by slip along the subduction thrust fault or by slip on faults within the down-going plate as a result of bending and extension as the plate is pulled into the mantle. Also known as the Wadati-Benioff zone.

Body Waves—waves that move within the Earth's interior or within a body of rock. P and S waves are body waves. See ***Surface Wave.***

Brittle Deformation—irreversible strain where the material fractures/breaks response to stress. *See Brittle Deformation.*

Compression—fractional decrease of volume due to pressure [see animation under Stress]

Compressional Wave—*P wave*.

Continental Rifting—process by which a continent stretches and splits apart; if successful, this process separates a larger continent into two smaller continents separated by an expanding ocean. See ***Plate Tectonics.***

Convergence—coming together or joining at a common point. At **Convergent Boundaries** tectonic plates are moving toward each other. See also ***Divergence***.

Crust—the outermost major layer of the earth, ranging from about 10 to 65 km in thickness worldwide. The uppermost 15-35 km of crust is brittle enough to produce earthquakes. Oceanic crust is thinnest; continental crust is thickest. Often mistaken for the ***tectonic (lithospheric) plate.*** *Watch* Take 2: Plate vs. Crust.

Deformation—process where rocks are folded, faulted, sheared or compressed by Earth stresses.

Dip—the angle by which a rock layer or fault plane deviates from the horizontal.

Dip Slip Faults—inclined fractures where the blocks have mostly shifted vertically. See ***Normal*** and ***Reverse Faults.***

Directivity—an effect of a fault rupturing whereby earthquake ground motion in the direction of rupture propagation is more severe than that in other directions from the earthquake source. USGS animation.

Divergence—moving apart from a common point. At **Divergent Boundaries** plates are moving apart. See also ***Convergence***.

Ductile Deformation— When rocks deform in a ductile manner they bend, instead of fracturing to form faults. The resulting structures are called folds. At high temperature and confining pressures, brittle rock can become ductile. Folds result from compressional or shear stresses acting over considerable time. (Watch Faults, Plated Boundaries & Stress from 3min 20sec.)

Earthquake—the sudden fracture and movement of rocks inside the Earth. Earthquakes extend anywhere from the crust to 680 km below the Earth's surface, and release stored elastic energy. Part of the energy released produces seismic waves, like P, S, and surface waves that travel outward in all directions from the point of initial rupture. These waves shake the ground as they pass by. An earthquake is felt if the shaking is strong enough to cause ground accelerations exceeding approximately 1.0 centimeter/second squared. ***Types of earthquakes*** include:

A) Tectonic Earthquake: occurs when the earth's crust breaks due to geological forces on rocks and adjoining plates that cause physical and chemical changes.
B) Volcanic Earthquakes: result from tectonic forces which occur in conjunction with volcanic activity.
C) Collapse Earthquakes: occur in underground caverns and mines during roof collapse.
D) Explosion Earthquakes: result from the detonation of nuclear and chemical devices.

Elastic Properties—the measure of an objects ability to change shape when a force is applied to it, and return to its original shape when the force on it is released.

Elastic Rebound—an objects ability to return to its original shape after being broken apart. See ***Strike-slip and Subduction.***

Elastic Strain— a form of strain that, when the deforming force is removed, the distorted body returns to its original shape and size. Earthquakes are caused by the sudden release of energy as strain is overcome and the sides of the fault move past each other. This form of energy release is the only kind that can be stored in sufficient quantity to be regionally damaging.

Epicenter—the point (map location) on the Earth's surface directly above the ***hypocenter***, or *focus* of an earthquake**.**
Watch Take 2:Epicenter vs. Hypocenter.

Fault—a fracture or zone of fractures in rock along which the two sides have been displaced relative to each other. If the main sense of movement on the fault plane is up (compressional; ***reverse***) or down (extensional; ***normal***), it is called a dip-slip fault. Where the main sense of slip is horizontal the fault is known as a ***strike-slip*** fault. Oblique-slip faults have both strike and dip slip.
See Normal Fault and Reverse Fault.

Fault Plane—The plane along which the break or shear of a fault occurs. It is a plane of differential movement, that can be vertical as in a strike slip fault or inclined like a s***ubduction zone*** fault.

Fault Zone—Since faults do not usually consist of a single, clean fracture, the term fault zone is used when referring to the zone of complex deformation that is associated with the fault plane. (Ex. San Andreas Fault Zone)

Focal Mechanism—The focal mechanism of an earthquake sums up (1) the slip motion of the rocks underground and (2) the orientation of the fault on which the slip occurred.

Focus—see ***Hypocenter***.

Fold—A bend or flexure in a rock that is a result of permanent deformation.

Footwall—The underlying side of a fault. If you walked on the fault plane, your foot would be on this wall.

Foreshock—Foreshocks are relatively smaller earthquakes that precede the largest earthquake in a series, which is termed the ***mainshock***. Not all mainshocks have foreshocks.

Fracture—Irreversible strain were the material is separated into two or more pieces.

Geotechnical engineering- relating to the type of civil engineering (or the use of scientific methods to plan and build structures) that is concerned with rocks and soil. Geotechnical engineering is important in any construction that occurs on the surface of or within the ground.

GPS Station- A Global Positioning System is a spaceborne radionavigation system that uses orbiting satellites to determine the exact location of the receiver on the surface of the earth. The Network of the Americas (NOTA) GPS stations is a core network of 1100 continuously operating Global Positioning System (GPS) stations managed as part of the Geodesy Advancing Geosciences and EarthScope (GAGE) Facility, the geodetic component of the National Science Foundation (NSF) EarthScope project. NOTA GPS stations are accurate to distances of less than one centimeter.

Ground Motion—Ground motion is the movement of the earth's surface from earthquakes or explosions. Ground motion is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.

Hanging Wall—Occurs above the fault plane. If you walked on the fault plane, this wall would be above our head.

Hazard—a source of unpredictable, unplanned danger. See ***Seismic Hazard.*** *Watch "*Take 2: Hazard vs. Risk*"*

Hypocenter— commonly termed the ***focus***, this is the point within the earth where an earthquake rupture starts. It is directly below epicenter generally between 1–50 km depth, but can be as deep as 600km in subduction zones.
Watch Take 2: Epicenter vs. Hypocenter.

Intensity—The intensity is a number (written as a Roman numeral) describing the severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures (i.e., what is experienced). See ***Magnitude***.
Watch Take 2: Magnitude vs. Intensity.

Interplate—pertains to processes between the earth's tectonic (lithospheric) plates.

Intraplate—pertains to processes within the plates.

Isoseismal—a contour or line on a map bounding points of equal ***intensity*** for a particular earthquake.

Kinetic energy—the energy an object possesses due to its motion.

Layers of the Earth—Crust, mantle, core. The brittle outer shell (crust and upper mantle) is responsible for earthquakes.

Liqefaction—a process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking.

Lithosphere—solid, rocky, outer part of the Earth, ~100 km thick (50 miles) comprised of the crust and the solid portion of the mantle. **The** thickness is age dependent with older lithosphere is thicker than younger oceanic lithosphere. The lithosphere below the crust is brittle enough at some locations to produce earthquakes by faulting, such as within a subducted oceanic plate.

Lithospheric Plate—See ***Lithosphere*** and ***Tectonic Plate.*** *Watch* Take 2: Plate vs. Crust.

Locked fault—a fault that is not slipping because frictional resistance is greater than the shear stress across the fault (it is stuck). Such faults may store strain for extended periods that is eventually released in an earthquake when frictional resistance is overcome.

Love Waves—***surface waves*** that move parallel to the Earth's surface and perpendicular to the direction of wave propagation..

Magma—molten rock material that is liquid or pasty which originated within the earth. Molten rock below the surface of the Earth. Lava is molten rock on the surface of the Earth.

Magnitude—a number that characterizes the relative size of an earthquake. Magnitude is based on measurement of the maximum motion recorded by a seismograph. Several scales have been defined, but the most commonly used are: (1) local magnitude (ML), commonly referred to as "***Richter magnitude***," (2) surface-wave magnitude (Ms), (3) body-wave

magnitude (Mb), and (4) ***moment magnitude*** (Mw). Scales 1-3 have limited range and applicability and do not satisfactorily measure the size of the largest earthquakes. The moment magnitude (Mw) scale, based on the concept of seismic moment, is uniformly applicable to all sizes of earthquakes but is more difficult to compute than the other types. All magnitude scales should yield approximately the same value for any given earthquake. *Watch* Tale2: Magnitude vs. Intensity.

Mainshock—the largest earthquake in a sequence, sometimes preceded by one or more foreshocks, and often followed by aftershocks.

Mantle—the layer in Earth's interior between the crust and the metallic core. The uppermost mantle is part of the ***tectonic plate***.

Material Properties of the Earth—the bulk character of the rock, such as composition, density, elastic moduli, mineralogy, and phase (ex. the presence of melt). Elastic waves may propagate through the earth in a manner which depends on the material properties of the earth. The elasticity of the material provides the restoring force of the wave.

Modified Mercalli Intensity Scale—commonly used ***intensity*** scale that assigns a number describing the perceived severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures. (See ***Intensity***.)

Moho—the boundary between the crust and the mantle in the earth. This is a depth where seismic waves change velocity and there is also a change in chemical composition. The boundary is between 25 and 60 km deep beneath the continents and between 5 and 8 km deep beneath the ocean floor. Also termed the Mohorovicic' discontinuity after the Croatian seismologist Andrija Mohorovicic' (1857-1936) who discovered it.

Moment Magnitude—the preferred measure of earthquake size (***magnitude***) in which takes into account the stiffness of the rock, the average slip on the rupture plane, and the area of the rupture plane in addition to the maximum motion (amplitude) recorded by a seismograph (the "moment" of the earthquake). See ***Magnitude***.

Normal Fault—a fault, formed by extension, where the main sense of movement on the ***hanging wall*** is down.

Oblique-slip fault— has both ***strike-slip*** and ***dip-slip*** components.

P Wave—the primary body wave; the first ***seismic wave*** detected by seismographs; able to move through both liquid and solid rock.. Also called compressional or longitudinal waves, they compress and expand (oscillate) the ground back and forth in the direction of travel, like sound waves that move back and forth as the waves travel from source to receiver. P wave is the fastest wave.

Peak Acceleration—largest increase in velocity recorded by a particular station during an earthquake. (Commonly called PGA for peak ground acceleration). See ***Acceleration*** and ***Spectral Acceleration***. Learn More about PGA–Wiki.

Plastic Deformation—an objects ability to change shape under an additional amount of stress beyond its elastic limit before it breaks.

Plate—a large, relatively rigid segment of the Earth's lithosphere that moves in relation to other plates over the asthenosphere. See ***Plate Tectonics*** and ***Lithospheric Plate***. *Watch* Myth-conception: Plate vs. Crust.

Plate Boundary—the tectonically active contact between tectonic plates can be convergent, divergent, and transform.

Plate Tectonics—the theory supported by a wide range of evidence that considers the earth's crust and upper mantle to be composed of several large, thin, relatively rigid plates that move relative to one another. Slip on faults that define the plate boundaries commonly results in earthquakes. See Tectonic Plate and Lithospheric Plate. (Watch the animations: History of Plate Tectonics Theory and What are the Forces that Drive Plate Tectonics)

Potential Energy—the stored energy of an object due to its position or condition.

Primary Wave—See ***P Wave.***

Propogate—to cause a wave to move through a medium

Rate—an expression that describes a change in position or velocity with respect to time.

Rayleigh Waves—***surface waves*** that move in an elliptical motion, producing both a vertical and horizontal component of motion in the direction of wave propagation.

Recurrence Interval—the average period of time between earthquakes in a seismic region.

Reflection—the energy or wave from an earthquake that has been returned (reflected) from an boundary between two different materials within the earth, just as a mirror reflects light.

Refraction—with respect to (1) earthquakes and (2) tsunamis:
(1) The deflection, or bending, of the ray path of a seismic wave caused by its passage from one material to another having different elastic properties.
(2) Bending of a tsunami wave front owing to variations in the water depth along a coastline.

Resonance— resonance is a phenomenon that consists of a given system being driven by another vibrating system (by external forces) to oscillate with greater amplitude at some preferential frequencies. All buildings have a natural frequency of oscillation or resonance frequency.

Reverse Fault—fault formed by compression, where the main sense of movement on the hanging wall is up.

Richter Scale—mathematical device to compare the size of earthquakes that is applicable for local earthquakes below magnitude 7. (For larger earthquakes see ***Moment Magnitude.***) The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value. The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology. See ***Magnitude***.

Ring of Fire—40,000-km-long region that surrounds the Pacific Ocean known for its 452 volcanoes and 90% of the worlds earthquakes. Also called the Circum-Pacific belt, this zone of earthquakes includes 81% of the worlds largest earthquakes.

Rock—a naturally occurring, solid, comprised of a combination of one or more minerals formation.

S Waves—shear waves that are secondary body waves that oscillate the ground perpendicular to the direction of wave travel. They travel about 1.7 times slower than P waves. Because liquids will not sustain shear stresses, S waves will not travel through liquids like water, molten rock, or the Earth's outer core. S waves produce vertical and horizontal motion in the ground surface.

Segmentation—Segmentation is the breaking up of a fault along its length into several smaller faults. This can happen as a result of other faults crossing it, topography changes, or bends in the strike of the faults. Segmentation can limit the length of faulting in a single earthquake to some fraction of the total fault length, thus also limiting the size of the earthquake.

Seismic Hazard—includes natural hazards associated with earthquakes that have potential to cause harm and affect the normal activities of people. This includes surface faulting, ground shaking, landslide, liquefaction, tectonic deformation, tsunamis, and seiches. See ***Seismic Risk***. *Watch:* Take 2: Hazard vs. Risk

Seismic Moment—a parameter related to the angular leverage of the forces that produce slip on a fault; determined from the seismic waves and field measurements that describe the fault area. See ***Moment Magnitude***.

Seismicity—the geographic and historical distribution (the "where?" and "how often?") of earthquakes.

Seismic Risk—the probability (chance) that humans will incur loss or harm if someone or something that is vulnerable is exposed to a seismic hazard. See ***Seismic Hazard***.

Seismic Tomography—an imaging technique that uses seismic waves generated by earthquakes and explosions to create computer-generated, three-dimensional images of Earth's interior.

Seismic Wave—an elastic wave generated by an impulse such as an earthquake or an explosion. Seismic waves may travel either through the earth's interior (P and S waves; the fastest waves) or along or near the earth's surface (Rayleigh and Love waves). Seismic waves travel at speeds of several kilometers per second.

Seismogenic—capable of generating earthquakes. The base of the seismogenic (brittle) zone is the top of the ductile asthenosphere.

Seismogram—the real-time record of earthquake ground motion recorded by a seismograph. Seismograms are the records (paper copy or computer image) used to calculate the location and magnitude of an earthquake..

Seismograph—an instrument that records vibrations of the Earth, especially earthquakes. Seismograph generally refers to the seismometer plus a recording device as a single unit.

Seismology—science that deals with earthquakes and attendant phenomenon including the study of artificially produced elastic waves in the Earth's material.

Seismometer—a sensitive instrument that can detect waves emitted by even the smallest earthquakes. See ***Seismograph***.

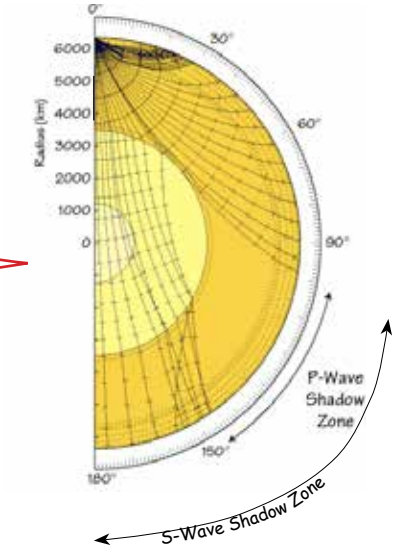
Shadow Zone—the area of the earth from angular distances of 104 to 140 degrees from a given earthquake that does not receive any direct P waves. This zone results from S waves being stopped entirely by the liquid core and P waves being bent (refracted) by the liquid core.

Shear—type of strain in which the shape of a material is displaced laterally with no corresponding change in volume.

Shear Wave—See ***S wave.***

Solid—Anything that retains a fixed volume and shape.

Spectral Acceleration—Whereas peak acceleration (PGA) is what is experienced by a particle on the ground, spectral acceleration (SA) is approximately what is experienced by a building, as modeled by a particle on a massless vertical rod having the same natural period of vibration as the building.



Seismic shadow zones.

Strain—change in the shape or volume of a material, often recorded in three-dimensions. Strain is defined as the amount of deformation an object experiences compared to its original size and shape. For example, if a block 10 cm on a side is deformed so that it becomes 9 cm long, the strain is (10-9)/10 or 0.1 (sometimes expressed in percent, in this case 10 percent). Learn more.

Stress—a measure of forces acting on a body. Stress is defined as force per unit area. It has the same units as pressure, and in fact pressure is one special variety of stress. However, stress is a much more complex quantity than pressure because it varies both with direction and with the surface it acts on. Learn more. Watch how Stress is related to plate boundaries.

Strike-slip Fault— the main sense of slip across the fault is horizontal. Can be right lateral (ground on opposite side of fault is moving right with respect to the other block) or left lateral (ground opposite moves left).

Strong Motion—ground motion of sufficient amplitude and duration to be potentially damaging to a building or other structure.

Subduction—the process of the oceanic lithosphere converging with, and descending beneath the continental lithosphere.

Subduction Zone—the place where two lithospheric plates, one oceanic and one continental, come together. The continental plate will ride over the oceanic plate. Most volcanoes on land occur parallel to and inland from the boundary between the two plates. See ***Convergent Boundary***.

Surface Wave—waves that move close to or on the outside surface of the Earth rather than through the deep interior like the faster P or S waves. Two principal types of surface waves, Love and Rayleigh waves, are generated during an earthquakes. Rayleigh waves cause both vertical and horizontal ground motion, and Love waves cause horizontal motion only. They both produce ground shaking at the Earth's surface but very little motion deep in the Earth. Because the amplitude of surface waves diminishes less rapidly with distance than the amplitude of P or S waves, surface waves are often the most important component of ground shaking far from the earthquake source.

Syncline—A downward-curving (concave) fold in rock. After erosion, the youngest beds are exposed in the central core of the fold. See ***Fold*** and ***Anticline.***

Tectonics—large-scale deformation of the outer part of the Earth resulting from forces in the Earth. See ***Plate Tectonics***.

Tectonic Earthquake—an earthquake that is due to the movement of the tectonic plates. Tectonic earthquakes will occur anywhere within the earth where there is sufficient stored elastic strain energy to drive fracture propagation along a fault plane. Other earthquakes can be caused by blasts or volcanic activity.

Tectonic Plates—the large, thin, relatively rigid plates that move relative to one another on the outer surface of the Earth. Comprised of the solid section of the Earth's crust and outermost mantle that moves over the deeper mantle. Also known as ***Lithospheric Plate***.

Teleseismic—earthquakes at distances greater than 1,000 km from the measurement site.

Tension—the stretching or extension of a material.

Velocity—how fast a point on the ground is shaking as a result of an earthquake.

Velocity Structure—a generalized regional model of the earth's crust that represents crustal structure using layers having different assumed seismic velocities.

Wave—a disturbance that moves through a system. See ***Seismic Wave***.

Wave Height—the vertical distance from a wave's crest to its trough. This measurement will be twice the amplitude measured for the same wave. See ***Amplitude.***

Wave Crest—the highest point a wave reaches. The lowest point is called its trough.See ***Amplitude.***

Wave Path— As a wave travels through Earth, the path it takes depends on the velocity and the material it passes through. ***Body waves*** and ***surface waves*** travel different paths.

Wave Trough—the lowest point a wave reaches. See ***Amplitude.***

Wavelength—the horizontal distance between two successive crests, often measured in meters.

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www.iris.edu/earthquake/animations