Term	Definition	Section
absolute plate movement (also, true plate motion)	The movement of a lithospheric plate with respect to a fixed frame of reference.	2.2
accessory mineral (accessory phase)	A mineral phase within a rock whose presence does not affect the root name of the rock. For instance, the root name 'granite' is defined by the presence of quartz, alkali feldspar, and mica. These are the 'essential minerals'. The presence of the mineral sphene does not affect the root name and hence would be an example of an accessory mineral. Apatite and zircon are also common accessory minerals. (cf essential mineral)	3.7
accrete	Process by which sediments 'stick', or are transferred, onto the overriding plate, from the subducting plate.	2.3
accretionary prism	A typical feature of trench areas of subduction zones. It is a thickened layer of sediment on the overriding plate. It results from both compression of the sediment on the overriding plate, and accretion of (additional) sediment from the other (subducting) plate. They are composed of slices of deep-water sediment, impacted into each other	2.3
accretionary wedge	Same as accretionary prism.	2.5
acid rock	Silicic content high - acid - SiO_2 >70% e.g. granite	4.1
active margin	A continental margin that is seismically and volcanically active. The magnetic stripes of the ocean sea floor are incomplete - some may be 'missing' at the continental border (cf passive margin)	2.2
Adams-Williamson equation	An equation to calculate the variation of density with depth as a function of density, mass and seismic velocities (?, m, vP, vS) at a particular radius r from the Earth's centre. (It allows K, the bulk modulus to be eliminated from the earlier equations.) It assumes that density is related only to depth, i.e. to the amount of compression. (self-compression). It is valid only within layers of homogeneous material, i.e. with uniform chemical composition.	1.1
adiabatic temperature increase	A temperature increase due only to increasing pressure. i.e. if volume has not changed, and no heat been added to or lost from the systems w.r.t. to the Earth, this is a temperature increase at depth (i.e. due only to self-compression)	1.1
adiabatic temperature gradient.	The gradient of temperature increase with self-compression	1.1
aftershock	Smaller earth movements that often follow large-magnitude earthquakes. Often considered to be the mechanical readjustments in the crust or mantle, following the disruption of the main shock.	1.05
Airy's hypothesis of isostasy	Proposes that each column comprises an upper and a lower zone. The same two densities apply to all columns, so the difference in height of the columns depends on the relative amounts of low-density and high-density material.	1.08
albite ($NaAlSi_3O_8$)	An alkali feldspar	3.2
alkali feldspar	albite ($NaAlSi_3O_8$) and orthoclase ($KAlSi_3O_8$). Only partial ionic substitution can occur between these end-members, so they do *not* constitute a solid-solution series.	3.2
aluminosilicates	3 minerals that are Al-rich and occur as minor components in many rocks: kyanite, andalusite and sillimanite. All are polymorphs of Al_2SiO_5. o kayanite indicates high pressure o andalusite indicates low pressure o sillimanite indicates high temperature	4.4

Term	Definition	Section
Andean margin	A 'natural' continental margin, where an oceanic plate is being subducted beneath continental crust.	2.5
angle of incidence	Angle at which the wave strike the boundary.	1.06
angular velocity (?)	The angle through which a body rotates in a unit of time. Measured in radians.	1.1
anisotropic	'not isotropic' - <<<has different physical properties in different directions, such as its refractive index – so the behaviour of seismic waves varies>>>)	1.07
anorthite ($CaAl_2Si_2O_8$)	The end-member for plagioclase, used in the ternary system An-Fo-Di for basaltic composition	3.2
anion	A negative ion (as opposed to cation, a +ve ion)	
Apollo asteroids	Asteroids with orbits overlapping (but larger than) that of the Earth (cf Alen)	1.02
apparent polar wander	The wander of the Earth's magnetic axis, relative to moving plates (within the hot spot reference).	2.2
apparent polar wandering curve	The plotted position of the Pole, given (at least) 2 samples of magnetised rock from a continent that is assumed *not* to have moved.	2.2
Arc-continent collision	Often precedes full continental collision.	2.5
aspect ratio	Width (e.g. of convection cells,) divided by height.	1.14
asteroids	cf Apollo and Aten asteroids	1.02
asthenosphere	The layer in the upper mantle that can flow	1.07
asymmetric spreading	Sea-floor spreading that occurs at different rates on the different sides of the constructive margin (leading to magnetic stripes of different widths)	2.4
Aten asteroids	Asteroids with orbits lying mainly within that of Earth (cf Apollo)	1.02
Atomic mass unit	a unit of the atomic mass scale which is an arbitrary scale of relative masses. It is based on the carbon isotope 126C, which has a mass of 12 atomic mass units.	1.1
atomic nuclei	Protons and neutrons (except hydrogen, no neutron)	1.04
atomic number	Number of protons on the nucleus	1.04
attenuate	Reduction in amplitude (strength) of the seismic wave with distance from the focus. The energy of the original wave is dissipated as heat. <<< confirm>>>	1.05
attenuation	Dissipation of energy	1.05
AU - Astronomical Unit	The mean distance of the Earth from the Sun. 1.496 x 10e8 km	1.02
auxiliary plane	The plane at 90° to the fault plane (when view from above)	1.05
average rate of movement	The rate of plate movement, estimated over a period of geological time (> a few Ma) (cf instantaneous rate of movement)	2.2
axial modulus (an elastic modulus)	A special type of Young modulus, when there is no lateral strain.	1.06
back-arc basin	A small basin, bounded by an active island arc on one side and an extinct island arc on the other. (Found at oceanic convergent plate boundaries)	2.3
basaltic rock	Silicic content low - SiO_2 = 50% (45% - 52%)	4.1
bathymetry	The measurement of the depth of the ocean floor from the water surface. (The oceanic equivalent of topography)	2.2
Bénard cells	Convection cells that are as tall as they are wide. They form in a stable, hexagonal pattern, and are the first convection pattern in a heated fluid. (cf turbulent convection)	1.14

Term	Definition	Section
Benioff zone	One of the zones of deep earthquake hypocentres whose existence was first demonstrated in 1927 by the Japanese seismologist Kiyoo Wadati. The zones were mapped in the 1940s and 50s by Hugo Benioff. They dip from near-surface to a maximum depth of approximately 700 km and are associated with oceanic trenches, island arcs, volcanic chains, and young fold mountains,and are thought to indicate active subduction. See Subduction Zone.	1.05
big bang	The hypothesis that the birth of the Universe was 15 Ga, as a fireball of very hot, dense matter.	1.04
binary system	A solid-solution series with two end-members. (e.g. the olivine series, with end-members forsterite and fayalite)	3.4
blob model (for the formation of the Earth's core)	The blob model (60's – 90's) held that large blobs of liquid iron, 100's km in size, accumulated and percolated through the solid mainly-silicate matrix, due to being denser. These iron blobs sunk to produce the core. However, in 1990 it was established that liquid iron cannot percolate solid silicate.	1.03
body waves	seismic waves that travel through the Earth's interior (body). e.g. P-waves and S-waves. Centred on the earthquake's focus.	1.05
body-wave magnitude	Based on the maximum amplitude of body waves, usually P-wave, with period 12s.	1.05
Bouguer anomalies	Those anomalies plotted on a Bouguer map – gravity values relative to the IGF, that have had all 4 gravity corrections applied to them. Used for most land surveys.	1.08
Bouguer anomaly	It gives information on the density distribution beneath the ground surface.	1.08
Bouguer anomaly map	A gravity map of an area, with gravity expressed not as absolute values, but in mGal relative to the IGF. All 4 gravity corrections (latitude, free-air, Bouguer and terrain) have been applied to values before plotting.	1.08
Bouguer correction, ?3g	The correction for a solid material between a reference station (P) and a field station (S). The Bouguer correction is the gravitational effect of an infinite horizontal slab of rock of density (?) and thickness h.	1.08
boundary layer model	A model to explain the base, and thickness, of the lithosphere. It proposes that Lithosphere does not have a constant thickness, but cools and thickens as it moves away from the oceanic ridge. (cf plate model)	1.12
bulk modulus K (or volume elasticity) (an elastic modulus)	bulk modulus, K = stress/strain = (F/A) / (?V / V) Applies to compression and dilatation.	1.06
bulk partition (distribution) coefficient *D*	Most magmas involve >1 phase. *D* = (concentration in crystal assemblage) / (concentration in a coexisting liquid) = C_c/C_l (crystal assemblage > 1 mineral) It depends on the proportion (by mass) of the element in each mineral, and the mineral partition coefficient for each mineral present.	3.7
carbonaceous chondrites (C-chondrites)	Meteorites containing both silicates and a mixture of abiogenic organic compounds	1.04
cation	A positive ion (as opposed to anion, a -ve ion)	
CEM	(see chondritic Earth model)	1.04
centrifugal force	The outward force at the surface, opposing the inward gravitational force, caused by the rotation of a body	1.08
chalcophile elements	Elements with a preferential tendency to form sulphides. (cf lithophile, siderophile)	1.04

Term	Definition	Section
channel-flow model (cf deep-flow model)	A model of mantle convection, wherein the mantle flow associated with (e.g. ice) loading is restricted to a relatively shallow depth range (thickness <200km) – much less than in the deep-flow model. In this model, there is a pronounced bulge in the crust, around the depression caused by the ice sheet.	1.14
chemical variation diagram	A diagram in which the concentration of one element (or, more usually, oxide in rock study) is plotted against that of another element, in each sample from a range of rocks.. When studying magmas, we plot Al_2O_3, CaO and MgO, as they are the major constituents in basalts.	3.6
chondritic Earth	An Earth with the same overall composition as carbonaceous chondrites	1.04
chondritic Earth model (CEM)	The hypothesis that the Earth is a chondritic Earth.	1.04
clinopyroxene	High-Ca pyroxene	3.2
clinopyroxene	Ca- bearing pyroxenes, which consist of mixtures of the end-members diopside, hedenbergite, and also enstatite and ferrosilite.	3.2
Combined plate boundary	A combination of conservative a boundary with either a constructive or a destructive boundary	2.3
compatible element	An element whose partition coefficient is >1, so is *more* concentrated in a given mineral than in a coexisting liquid. (cf incompatible)	3.7
complete ionic substitution	Total substitution of ions continuously between end members of a solid-state solution, of isomorphs - i.e. all compositional variants can occur between the end-members. Generally, this is only possible if the difference in ionic radii is <= 15% of the radius of the smaller ion.	3.2
compositional phase diagram	A diagram that involves the plots of composition against either temperature or pressure.	3.4
compression	The stress at a convergent margin!	2.5
conduction	1. (thermal conduction) The transmission of heat through a substance from a region of high temperature to a region of lower temperature. In gases and most liquids, the energy is transmitted mainly by collisions between atoms and molecules with those possessing lower kinetic energy. In solid and liquid metals, heat conduction is predominantly by migration of fast-moving electrons, followed by collisions between these electrons and ions. In solid insulators the absence of free electrons restricts heat transfer to the vibrations of atoms and molecules within crystal lattices. See conductivity. 2. (electrical conduction) The passage of electric charge through a substance under the influence of an electric field. See also charge carrier; energy band.	1.03
conduction layer	A more correct term for the thermal lithosphere,	1.13
consensus value	A 'best guess', that usually lies roughly midway between the highest and lowest estimate.	1.04
Conservative plate boundary	In plate tectonics, a plate margin where the movement of the plates is parallel to the margin. The San Andreas Fault in California is a conservative boundary with the Pacific Plate to the west of the fault moving northwards in relation to the south-moving North American Plate on the continental side.	2.2
Constructive plate boundary	Also termed a spreading ridge, spreading axis, or mid-ocean ridge.	2.2
continental margins	cf inactive aseismic (passive) margins and seismically active margins	1.09
continental plate	A plate with a significant component of continental crust	2.5

Term	Definition	Section
continuous refraction	The gradual change in wave direction due to a gradual change in seismic velocity. It occurs (mainly!) because within each layer of the Earth, the seismic velocity generally increases with depth. Thus, 1/v (which represents the gradient of the time-distance plot) also varies with depth.	1.07
convection	1. Vertical circulation within a fluid that results from density differences caused by temperature variations. Convection currents occur in the oceans when a water mass that is denser than the water below it sinks and is replaced by lighter, warmer water. 2. In meteorology, the process in which air, having been warmed close to the ground, rises. The convective uplift of air parcels is one of the main processes leading to condensation and cloud formation. See also dish-pan experiment; forced convection; Hadley cell; instability; level of free convection; and stability. 3. Within the Earth, the radiogenic heat release results in convective motions causing tectonic plate movements. The location and configuration of the convective cells is uncertain, but they appear to be mantle-wide and marked by most heat loss along the mid-ocean ridges. The difference in temperature between upgoing and downgoing convective limbs within the mantle may be only 1-2°C. In the upper oceanic crust, heat loss is mainly by convective circulation systems combined with thermal conduction. See	1.03
convergent margin	Destructive plate boundary	2.3
cosmic abundances of elements	The assumed relative abundance of elements (only partially tested, and only in the Solar System)	1.04
cotectic	The place on a phase diagram where 2 (or more) solid phases can coexist, together with a liquid (at equilibrium). Three cotectic lines on a ternary diagram divide the triangle into three areas, each area supporting a liquid and a single mineral (that of the enclosed corner) in equilibrium. The three cotectic points meet at the ternary eutectic	3.6
coupled substitution	If a substitution occurs that would leave a structure in electrical imbalance, then 2 substitutions must occur, so that there is electrical balance. (e.g. CaAl for NaSi in the plagioclase feldspar series)	3.2
creep	Solid-state creep	1.14
critical angle	Angle at which the angle of refraction is 90°, so the wave travels along the boundary (causing refraction)	1.06
critical distance	An area between the wave source (S) and the emergence of the first refracted wave (C) where no refracted waves emerge.	1.06
critical Rayleigh value	A critical value that must be reached for convection to occur.	1.14
crust, mantle, outer core, inner core	Chemical divisions of the interior of the Earth, bounded by major (conspicuous) discontinuities. (the Moho, Gutenberg and Lehmann discontinuities)	1.07
crustal growth	Rock (e.g. granite) formed from the mantle	4.3
crustal remelting	Rock (e.g. granite) formed from the melting of sediments	4.3
crustal root	(Continental) crustal rock that goes far deeper than normal, thereby supporting mountains. <<<maybe>>>	2.5
cumulate crystals (cumulates)	The crystals that are removed from a liquid and accumulate in a layer, during fractional crystallisation.	3.6
D'' layer	A layer of thickness about 100-200km at the base of the lower mantle (i.e. above the core-mantle interface). Both P- and S-wave velocities decrease here, by a few %. It may be the result of iron diffusing out of the core into the mantle, or a region of anomalously high temperature produced by heat from the core, or both!	1.07

Term	Definition	Section
decay constant	A value used in geochronology, that is related to the half-life of a radioactive isotope. It is the probably that an atom will decay in unit time t, and is usually expressed in units of 10e-10 per year. The decay constant is a characteristic of a radioactive isotope (i.e. is a constant for a specific isotope).	4.3
deep earthquake	depth of focus = >300 km	1.05
deep-flow model (cf channel-flow model)	A model of mantle convection, wherein the mantle flow caused by (e.g. glacial) loading occurs over a wide depth range, to a depth equivalent to at least the radius of the ice sheet. (The bulge of the channel-flow model is absent, or much smaller in size)	1.14
dehydration reactions	Chemical reactions that release water. They occurs at 50-100km depth, on the upper surface of an initially-cold subducting slab.	4.2
depth of focus	focal depth	1.05
derivative magma	Evolved magma	3.6
Destructive plate boundary	The contact between two lithospheric plates which are moving towards each other and where oceanic crust is being destroyed by subduction. Destructive margins, a type of convergent margin, are marked by shallow- to deep-focus earthquakes and typically andesitic volcanicity, and most are also marked by an oceanic trench.	2.2
differentiated meteorites	Achondrites, iron-meteorites and stony-iron meteorites, which are thought to have come from differentiated asteroids. However: they are not themselves differentiated.	1.04
differentiation	Separation of the planet into crust, mantle and core; i.e. into distinct layers of different materials	1.03
diopside ($CaMgSi_2O_6$)	A Ca-bearing pyroxene that is used an end-member in the olivine-clinopyroxene binary eutectic system. It is rich in Mg.	3.2
direct wave	A seismic wave which travels through the ground directly from the source to the detectors without being reflected off or refracted by a subsurface layer.	1.06
discontinuity	A velocity boundary between 2 layers of the Earth, in which the seismic wave velocities are quite different. This may be because the 2 layers are of different materials; or for other reasons.	1.06
distribution coefficient K_D	See partition coefficient	3.7
djerfisherite	A sulphide of Fe and K , found in small quantities in some meteorites, where it is often closely associated with troilite (FeS).	1.11
double-couple source (Type II source) (cf single-couple source)	The more likely source of a fault-generated earthquake. The fault planes are rugged, so some motion is at right-angles to the main fault motion. Both P-wave and S-wave radiation patterns are 4-lobe.	1.05
dunite	A peridotite containing only olivine (so neither low-Ca nor high-Ca pyroxenes)	3.2
Dynamic viscosity (?)	A measure of the ease with which layers of a fluid can move relative to each other	1.14
earthquake epicentre	The point on the Earth's surface, vertically above the earthquake focus	1.05
earthquake focus	The small volume (maybe several cubic km) that can be regarded as the point source of earthquake waves. Also referred to as its hypocentre.	1.05
earthquake hypocentre	same as earthquake focus	1.05

Term	Definition	Section
earthquake magnitude	An objective, absolute measure of the size of an earthquake, based on the amount of energy released when the earthquake takes place. The scale is based on seismic wave amplitude, and is always logarithmic. It may be based on body or surface wave amplitude, and always specifies the period (or frequency) of the waves whose amplitude is being used to define the magnitude.	1.05
ecliptic	The plane formed by the orbit of the Earth around the Sun.	1.02
eclogite	A rock type that has the same chemical composition as basalt, that consists of pyroxene and garnet, and is found as a mantle nodule.	3.2
eclogite	A dense metamorphic rock composed of red garnets and green pyroxenes. It is the result of temperature and pressure on plagiofeldspar and pyroxene, at depths of about 100km on a subducting slab.	4.2
EF	Enrichment factor	1.11
effective boundary length	This is the length of a plate boundary which is capable of exerting a net driving or resistive force. (Two ocean ridges of equal length on opposite sides of a plate exert no net force on the plate, as their effects cancel each other out).	2.6
elastic lithosphere	The layer that flexes when loaded, but returns to its original shape when the load is removed.	1.13
elastic modulus	The property of a material that defines its resistance to deformation. Elastic modulus = stress/strain. If a material deforms easily, then its strain is large, so its elastic modulus is small. There are several elastic moduli, corresponding to different types of strain; e.g. Young's modulus, bulk modulus and shear modulus.	1.06
elastic rebound theory	Theory which holds that accumulated potential energy, stored as elastic strains, is released by faulting (i.e. when the material ruptures). Zones adjacent to the fault plane 'rebound' elastically, leaving them relatively unstrained. <<< The explanation of fault-generated earthquakes, where crustal forces operate to move blocks against each other. When strain within rock has built up to a certain point, movement occurs and the strain is released (or reduced), leaving the blocks offset from each other.>>>	1.05
elastic waves (cf plastic)	Waves that pass through a rock that acts elastically; i.e. as its particles vibrate, the rock deforms momentarily; but returns to its original configuration.	1.05
elevation correction (or free-air correction) (?2g)	g will decrease with increasing height above the Earth's surface, so the effect of the difference in height must be removed from a measured gravity difference between a reference station (P) and a field station (S). ?2g is derived by using the heights of P and S, as d.	1.08
emulsion	a mixture in which one substance is suspended in another.	1.03
end members	Two models that are extremes. (The truth may lie between them.)	1.14
end-members	The chemical variants at the ends of a solid-state series. They are those that have the 'most' (and 'least') of any defining element. For example, the end-members of olivine are fayalite and forsterite.	3.2
endothermic	Reaction requiring heat energy.	1.04
enrichment factor (EF)	The abundance of an element in the mantle, divided by its abundance in chondrites	1.11
enstatite ($Mg_2Si_2O_6$)	An end-member of the solid-state series of orthopyroxenes. (with ferrosilite)	3.2
enstatite chondrites (E-chondrites)	Meteorites containing a high abundance of the mineral enstatite (MgSiO3)	1.04

Term	Definition	Section
epicentral angle ? (delta)	Measured in degrees, the angle subtended at the centre of the Earth, by that part of the Earth's circumference between the earthquake and the seismometer. Also influenced by h, the depth at which the earthquake takes place.	1.05
essential mineral	A primary mineral whose presence in an igneous rock is essential in defining the root name of that rock. (cf accessory mineral)	3.7
eutectic	A system in which the member crystals exist separately in the solid (rather than in a solid-solution), so there are separate solid phases per component.). o The mixture beings to melt at a point that is *less* than the melting temperature of any of the pure members (the eutectic point). o Furthermore; (unlike the solid-solution system), the solidus does not depend on the bulk composition of the forsterite-diopside mixture. Instead, it is a horizontal line. (1580ºC at 1.5GNm-2 for the forsterite-diopside system). o The liquid produced at the eutectic point has a fixed composition, the eutectic composition.	3.4
eutectic composition	The composition of the liquid that is first produced (at the eutectic point) when melting a eutectic system.. o It is the *only* composition of liquid that can coexist with (pure) crystals of *all* members of a eutectic system. o It is independent of the mixture's bulk composition.	3.4
eutectic point (eutectic)	The point on a (binary) eutectic phase diagram where solids of all members, and liquid, can coexist. It defines the composition of, and temperature at which, the first melt forms. It is therefore the lowest temperature at which a liquid can exist (in a purely eutectic system).	3.4
evolved magma (derivative or fractionated magma)	Magma far removed in composition from primary magmas (relatively).	3.6
exothermic	Reaction producing heat energy	1.04
exotic terranes	A (fault-bounded) region that does not 'belong' where it is - perhaps a continental slice that was a microcontinent that has crossed an ocean and accreted to another continent!	2.5
exsolution	The 'unmixing' of a solid solution of minerals that is stable only at high temperatures. On cooling, the minerals become unstable and separate into 2 distinct minerals; such as Na- and K-rich feldspars in the alkali feldspar system (when solid solution is cooled below ~700 deg C.) In the alkali feldspars, this results in complex intergrowths between albite-rich and orthoclase-rich crystals.	4.3
extension	At spreading ridges, oceanic crust and its underlying mantle are being stretched by forces that are pulling the two plates apart. The main extensional forces are roughly horizontally oriented.	2.5
fault plane	A discrete, planar surface along which there has been appreciable relative displacement of the rock masses on either side.	1.05
fault-plane solutions	The determination of fault and auxiliary planes in a real, 3-D, spherical Earth	1.05
fayalite (Fe_2SiO_4) (cf forsterite)	A compositional variant of olivine, containing ALL iron and NO magnesium	3.2
Fennoscandia	Norway, Sweden and Finland	1.14
ferromagnesian silicate minerals	Silicates that contain both magnesium and iron. (Most mantle minerals are they)	3.2

Term	Definition	Section
ferrosilite ($Fe_2Si_2O_6$)	An end-member of the solid-state series of orthopyroxenes. (with enstatite)	3.2
first arrival	The times at which the first wave, beit refracted or direct, reaches "D", its detector. (cf second arrival)	1.06
first motions	The form of the wave to first reach the seismometer; either compressional or dilatational, in the case of P-waves.	1.05
fixed frame of reference	This may be a hotspot, palaeomagnetic Euler poles, or 'no net torque of all plates'	2.2
F-layer	A transition zone several 100 km thick between the outer and inner core where the P-wave velocity jumps (from ~10.4 km s-1 to ~11.0 km s-1). Or, so it is 'widely believed'!	1.07
flood basalt provinces	They are areas of perhaps $10^6 km^2$, covered by basalt lava flows perhaps 1km deep. It has been proposed that very high mantle temperatures (hot spots), and moderate lithospheric thinning, combined to allow such a high volume, and rate, of magma production. Alternatively, the mantle source rock may have a lower solidus temperature than has MORB, which involves a slightly different mantle composition. A small amount of water would be sufficient. A combination of the 2 probably accounts for flood basalts, but we can test neither theory. Most occur at the extinct end of hot spot chains.	3.5
focal depth = depth of focus	The vertical distance from the earthquake focus to the Earth's surface. Invariable less than 720 km.	1.05
folds	1. A bend in rock strata or in any planar feature. The feature (e.g. beddi	2.3
Forces and resistance acting on plate margins (see pfr)	Oceanic drag ; Continental Drag; Ridge-push and Hot-spot push ; Transform Fault resistance; Slab-pull; Slab resistance; Colliding resistance; Trench Suction; Bending resistance; Overriding plate resistance	2.6
foreshock	A small earthquake, sometimes occurring in swarms, that precedes a major earthquake (or volcanic eruption).	1.05
forsterite (Mg_2SiO_4) (cf fayalite)	A compositional variant of olivine, containing NO iron and ALL magnesium. (Being a mineral, it is crystalline - not a liquid or a glass)	3.2
fractional crystallisation	The regime in which crystals are continuously removed from a liquid during cooling. (e.g. from magma)	3.6
fractionated magma	Evolved magma	3.6
fracture zones	The areas beyond transform faults. They are not (necessarily) seismically active.	2.3
Fraunhofer lines	Dark lines seen in the spectrum of the Sun's light, as observed by Earth. They indicate frequencies of light that have been absorbed by elements in the photosphere of the Sun. The intensity of the Fraunhofer lines indicate the relative abundance of the absorbing element.	1.04
free-air anomaly maps	Gravity maps which show only anomalies after latitude and free-air corrections. Used most often by marine and satellite data more often use (i.e. the Bouguer and terrain corrections are not applied; as all measurements are made at the same height, and there is no terrain to worry about.)	1.08
free-air correction	elevation correction	1.08
fusion reactions	The fusion (or merging) of lighter elements into heavier ones.	1.04
galaxy	A cluster of stars, of which there are at least a billion in the known Universe.	1.02
Galaxy	The Milky Way galaxy	1.02
galaxy cluster	2-3 or >1000 galaxies, grouped together	1.02
galaxy supercluster	A group of galaxy clusters	1.02

Term	Definition	Section
geobarometer	A mineral (or group of minerals) whose existence is stable between known pressure bands, so gives a good indication of the pressure under which that mineral formed.	4.4
geochemical affinity	The tendency of an element to enter into a particular type of chemical combination. Maybe lithophile, chalcophile, siderophile. (Note, an element may be in 1,2 or 3 of these groups, due to opportunity – if there is not its preferred chemical available to combine with)	1.04
geoid	The real surface of sea-level at which measured gravity is equal to the theoretical IGF value, in the absence of smaller variations. It is usually expressed as elevation contours, above and below the theoretical spheroid surface; the literal heights of the sea-surface above and below the oblate sphere.	1.08
geotherm	Geothermal gradient; the increase of temperature with depth.	3.3
geothermal gradient	temperature gradient	1.12
geothermometer	A mineral (or group of minerals) whose existence is stable between known temperature bands, so gives a good indication of the temperature at which that mineral formed.	4.4
Global Positioning by satellite (GPS)	Used to measure modern plate movements	2.2
GLORIA	**G**eological **Lo**ng **R**ange **I**nclined **A**sdic. A sonar, towed at a depth of 50m, in water of 5km depth. It uses a sound beam to scan a zone of sea-floor about 60km wide. Sonographs thus produced reveal local topography, submarine canyons, submarine slides and small submarine volcanoes.	2.3
gneiss	A rock formed by high temperatures and pressures resulting in segregation of quartz and feldspar, and ferromagnesian minerals (such as biotite and amphibole). They exhibit a banded appearance (due to this separation of different coloured minerals)	4.4
Gondwanaland	115Ma ago, all the southern continents were one,	2.5
graben	See rift valley	2.5
granite minimum	In the quartz-albite-orthoclase ternary system, this is the common low temperature point at which the last melt crystallises following fractional crystallisation (or the first minerals begin to melt upon heating, from a granitic solid).	4.3
granulites	The residual dehydrated rock that is left when a granite is subjected to very high temperatures. They characterise much of the lower crust, where it is too hot for mica and amphibole to be stable.	4.4
Gravimeters	Used to measure gravity variations of 1 in 10e8, and reveal variations in g across the world	1.08
gravitational energy	energy that arises from the effect of gravity!	1.03
gravity anomaly (milligals (mGal))	the difference between the gravitational effect of a particular feature, and the effect with no such feature	1.08
gravity map	The final corrected value of gravity for each field station (gS - gP)corrected can be plotted on a map and contoured, producing a gravity map of the area. The gravity values on the map are not absolute values, but are values expressed in mGal relative to the IGF.	1.08
Gutenberg discontinuity	The boundary between the mantle and outer core. (more often, the core-mantle interface)	1.07
half-spreading rate	The movement of one plate away from the ridge (at a constructive plate boundary) (cf spreading rate)	2.2

Term	Definition	Section
harzburgite	A peridotite with only olivine and low-Ca pyroxenes (>5% each) but rare or no high-Ca pyroxene - limited mineralogy. It appears to originate from the upper mantle beneath the crust, and is found on the surface in fracture zones and in ophiolites.	3.2
H-chondrites	Subset of ordinary chondrites (oxidation: H ? L ? LL)	1.04
heat flow	means both the flow of heat, in general terms specifically, the rate at which heat flows through 1m2 of the Earth's surface, Wm-2.	1.12
heat generation	means both the generation of heat, in general terms specifically, the rate at which heat is generated in (either) 1 m3 of rock, or 1kg of rock.	1.12
heat-flow province	A distinctive area in the continental crust that is regional in extent. It can be characterised by a linear relationship between heat flow and heat generation, but with a specific thickness, and value for reduced heat flow.	1.12
hedenbergite ($CaFeSi_2O_6$)	A Ca-bearing pyroxene that is an end-member (along with diopside)	3.2
helium burning	fusion of helium to make elements up to 6C and 8O	1.04
hidden layer.	A layer (within the Earth) with a lower seismic velocity that occurs below another layer. (It will not appear on the time-distance graph as a first arrival, so will not be detected). (A layer may also remain hidden if its seismic velocity is higher than that of the layer above, but if the contrast in velocity is not very great, or if the layer is thin. But is this a hidden layer <<<???>>>	1.06
High Himalayan leucogranites	This is a series of light-coloured granites, emplaced as lenses and sheets into the sediments of the Himalayan mountains, just south of the Asian-Indian suture. They consist almost entirely of quartz, plagioclase and alkali feldspar. All intrusions are granitic in composition, containing 70 - 75% silica. They are all aged 20+/-5 Ma, so were intruded well after collision. They are intruded into migmatites that were formed from the partial melting of much older aluminous sediments. The observed mineral reaction in the migmatite provides a possible source for the granite. (cf trans-Himalayan batholith)	4.4
hot spots	Isolated volcanic areas away from constructive plate margins, such as Hawaii (and unusually active volcanic areas on constructive plate margins, such as Iceland).	2.2
hydrogen burning	The process of hydrogen fusing into helium. It occurs in a Suns deep interior, at 10e7K.	1.04
hydrothermal circulation	The circulation and heating of seawater in hot rocks at oceanic ridges.	1.12
IAB	Island Arc Basalt (cf MORB, OAB)	4.2
IGF	International Gravity Formula	1.08
inactive aseismic (passive) margins	One of two general types of continental margin, that does not form plate boundaries (typified by those around the Atlantic). (These are usually close to isostatic equilibrium.)	1.09
incompatible element	An element whose partition coefficient is <1, so is *less* concentrated in a given mineral than in a coexisting liquid. (cf compatible)	3.7

Term	Definition	Section
initial heat	o The standard model has the Earth accreting from cold rock fragments. When fully formed after 10e7 – 10e8 years of growth, it would have been very hot, with initial heat from a number of sources: Heat of accretion Heat of compression Core formation Short-lived radioactive isotopes Long-lived radioactive isotopes Tidal Dissipation	1.03
initial Sr-isotope ratio	The $^{87}Sr/^{86}Sr$ ratio at the time of formation of the rock. It reflects both the chemistry of the rock, and the age of the source region from which that particular rock was derived. The value for both the Earth, and chondritic meteorites, is believed to be 0.6990.	4.3
inner planets	The high-density planets, Mercury, Venus, Earth and Mars	1.02
instantaneous rate of movement	The rate of plate movement, estimated over periods much shorter than geological time (cf average rate of movement)	2.2
intermediate earthquake	depth of focus = 70-300 km	1.05
intermediate rock	Silicic content intermediate! - 52% <= SiO_2 <= 70% e.g. andesites, dactites	4.1
internal heating	(of the mantle), the creation of heat within itself (by radioactive isotopes)	1.14
International Gravity Formula (IGF)	This predicts the gravitational acceleration on the Earth as a rotating oblate spheroid, taking latitude (?) into. i.e. it predicts latitude-dependent variations in gravity seen across the surface of the Earth at sea level. It takes into account rotation and equatorial bulge.	1.08
island arc basalts		4.2
island arc	Series of volcanoes that lies on the continental side of an oceanic trench of a lithospheric plate. The volcanicity, whose products are mainly of intermediate composition, results from the subduction process; typically it occurs approximately 100 km above the down-going oceanic plate. Island arcs are the sites of strong seismic activity, and have distinctive thermal and magnetic properties. See also Benioff Zone; Plate Motions; and Plate Tectonics.	2.3
isochron	A line joining points of equal time intervals, on an isochron diagram. An isochron that is horizontal indicates an age zero, whilst the slope of linked isochrons (from samples of the same age) gives the age of those samples.	4.3
isochron diagram	A plot of many samples of the same age, often plotting $^{87}Sr/^{86}Sr$ ratio against $^{87}Rb/^{86}Sr$ ratios, used to establish the age of the rock samples.	4.3
isomorphism (cf polymorph)	The property of chemically-different variants of a mineral which have identical atomic structures; such as fayalite and forsterite.	3.2
isostatic anomaly	(Bouguer anomaly corrected to a sea-level reference point) MINUS (predicted anomaly of modelled root zone below sea-level, needed to satisfy Airy's or Pratt's hypothesis.) For isostatic equilibrium, this value = 0	1.08
isostatic equilibrium	A state of balance, such that all masses above the surface (e.g. mountains) have low-density material beneath them, to exactly counteract the additional mass.	1.08
isotope evolution diagram	A graph plotting $^{87}Sr/^{86}Sr$ against time, showing how the isotopic ratio varies with age.	4.3
kimberlite pipe	A vent of an explosive eruption, that rapidly transported a mix of magma and rock fragments from great depths (containing minerals such as diamond and peridotite nodules, both from the mantle).	3.2

Term	Definition	Section
Kimberlite pipes	Thought to have been derived directly from the upper mantle. These are steep-walled vertical pipes of (mainly) peridotite (that occur in Kimberly, SA, and elsewhere, where they are mined for diamonds). They are believed to have been formed by explosive volcanism involving gas-solid mixtures, with little or no liquid.	1.11
kinetic energy	the energy possessed by a body by virtue of its motion	1.03
Kuiper belt	Region stretching from Neptune's orbit to ~80AU, wherein lie a family of icy asteroids	1.02
latitude correction ?1g	The latitude effect, that must be removed from a measured gravity difference between a reference station and a field station. This correction is derived from the IGF.	1.08
Layer 1 of the 4-layer oceanic crust	The poorly-consolidated sediments forming the sea bed	1.07
Layer 2 of the oceanic crust	igneous in origin, Divided up into 2A, 2B and 2C: 2A: Found only on actively spreading ridges 2B: Forms the upper part of layer 2 where 2A is absent, e.g. in ocean basins 2C: Basaltic	1.07
Layer 3	The main oceanic layer, certainly igneous, probably mostly gabbro.	1.07
Layer 4	Not so named; but the 4th layer is the upper mantle.	1.07
L-chondrites	Subset of ordinary chondrites (oxidation: H ? L ? LL)	1.04
leaky transform	A transform fault with a constructive component (i.e. a type of combined plate margin). So called, because magma 'leaks' up from the upper mantle along the faults.	2.3
Lehmann discontinuity	Occasional name of the outer core - inner core boundary.	1.07
level of compensation	is identified as the top of the asthenosphere in which plastic flow of material occurs slowly at depth, in order to maintain isostatic equilibrium.	1.08
level of compensation	A level within the Earth's <volume>, above which all columns of material having the same cross-sectional area must have the same weight. It lies at a constant depth below the sea-level. Mass deficiencies and excesses must be above this level. It is identified as the top of the asthenosphere, in which plastic flow of material occurs slowly at depth, in order to maintain isostatic equilibrium.	1.08
lever rule	A graphical method to determine the proportion of liquid to sample. If o S = solidus, o L = Liquidus, o B = Bulk composition, Are plotted horizontally from the 100% end to the liquidus, then the proportion of the sample that is liquid = length BS / length LS	3.4
lherzolite	o A peridotite with both low-Ca (orthopyroxene) and high-Ca (clinopyroxene) pyroxenes (>5% each). o It has diverse mineralogy, and commonly contain an Al-bearing mineral: plagioclase, spinel or garnet. o It appears to have originated from deep within the mantle. o It is found on the surface in kimberlite pipes.	3.2
light year	9.46 x 10e12km	1.02
liquid line of descent	A line on a chemical variation diagram, that is the compositional path defined by the evolving liquids (as crystallisation removes (fractionates) some minerals.)	3.6
liquidus	The curve on a phase diagram above which the system is entirely liquid. It is the highest point at which it can exist as a solid (so has the highest crystallisation temperature).	3.3

Term	Definition	Section
lithophile elements	Elements with geochemical affinity (i.e. that preferentially enters into combination with) oxygen or as silicates. (cf chalcophile, siderophile)	1.04
lithosphere	The is the strong, outermost layer of the Earth. It comprises the crust and upper mantle, which (despite their chemical differences) are physically similar ('strongly coupled').	1.07
LL-chondrites	Subset of ordinary chondrites (oxidation: H ? L ? LL)	1.04
Local Group	A cluster of ~30 galaxies, including the Milky Way.	1.02
Love waves	Horizontal, shear waves, that are limited mainly to the Earth's surface (amplitude decreases rapidly with depth) Centred on the earthquake's epicentre.	1.05
lower mantle	That part of the mantle below the 670 km discontinuity.	1.07
Low-velocity zone (LVZ)	Within the upper 200km or so of the Earth, is a region where The P-wave velocity decreases.	1.07
LVZ	Low-velocity zone	1.07
magma ocean	The result of the total melting of the surface of the planet, to a depth of perhaps 100's km.	1.03
magmas	primary, primitive, evolved, parental, derivative and fractionated!	3.6
magnetic anomaly	Having removed variations for o Time-of-day variations, o Sunspots, o Regional magnetic variations due to anomalies in that part of the Earth's core, this is the difference between the 'present day' magnetic field, and the magnetic properties of the rocks in the survey site.	2.2
magnetic inclination	The angle of dip of a compass, that depends on the latitude in which the magnetic minerals of a rock formed. (e.g. steep inclinations in polar-rocks, shallow in equatorial).	2.2
magnetic time-scale	A means of comparing the relative ages of oceans near spreading-ridges, by reading the magnetic record from a ridge as a known series of magnetic polarity switches. If samples can be independently dated (e.g. radiometric dating) then the actual age of components of the magnetic time-scale, in Ma, can be established. Also, if that dated sample is of a known distance from the ridge, then the rate of sea-floor spreading can be calculated.	2.2
main belt (of asteroids)	Lying between Mars and Jupiter, where most asteroids lie.	1.02
major elements	Those that occur in concentrations >1%	3.7
mantle convection	The transfer of heat by movement of material within the mantle. Material derived from within the mantle is added to the lithosphere at constructive margins and cool lithosphere descends at subduction zones, thus some return flow of material must take place at depth. The return flow may involve only material at shallow depth below the lithosphere, or material through the whole mantle, or possibly two or more layers of convection cells transferring heat between the layers by conduction. Hot spots may overlie isolated plumes of material rising from the core-mantle interface.	1.02
mantle wedge	The prism of upper mantle material, above a subduction zone.	4.2
marginal sea	back-arc basin	2.3
mass deficiency	A volume of low-density material under the surface, such that the gravity attraction is less than would be expected, all corrections accounted for.	1.08

Term	Definition	Section
mass excess	A volume of high-density material under the surface, such that the gravity attraction is more than would be expected, all corrections accounted for.	1.08
measuring modern plate movements	can be done by: o Very Long baseline interferometry (VLBI) o Satellite laser ranging o Global Positioning by satellite (GPS)	2.2
median ridge	The central part of a mid-ocean ridge when it takes the form of a prominent valley	2.3
melt volume	When considering magma that has escaped to the surface, this is the thickness of the layer of oceanic crust, which is composed of extracted melt.	3.5
mesosphere	The region between the base of the asthenosphere and surface of the core.	1.07
metamorphism	The process of changing the characteristics of a rock in response to changes in temperature, pressure, or volatile content. Most metamorphic changes do not include bulk chemical changes, but merely the crystallization of new mineral phases. These isochemical changes cause major textural changes. Compare Metasomatism. See also Barrovian-Type Metamorphism; Barrow's zones; Burial Metamorphism; Dynamic Metamorphism; Regional Metamorphism; Thermal Metamorphism; and Metamorphic Grade.	1.04
Meteorite types	Meteorites can be classified by either their chemical composition, or there texture (petrology)	1.04
meteorites	Meteoroids that have hit a planet's surface.	1.02
meteoroids	Very small bodies orbiting the sun, from sand-grain size up to several km.	1.02
meteors	Meteoroids that enter the Earth's atmosphere.	1.02
microcontinent	A fragment of a continent that has 'rafted away' from the main continent, and becomes completely surrounded by oceanic crust. The Baja California Peninsula is currently separating from the main N. Atlantic mainland by the San Andreas Fault system, and the spreading ridge through the Gulf of California, and will ultimately become a microcontinent, surrounded by oceanic crust.	2.5
migmatite	A coarse-grained rock found in high-grade metamorphic terrains, where sequences from migmatite to granite are often found. They consist of a mixture, of (a) a high-grade metamorphic component (with gneissose texture) and (b) an igneous component with granite mineralogy. This granite component is thought to be a result of partial melting during extreme metamorphism, in which case, migmatites are a record of the initial stages of the generation of large bodies of granite magma, so represent the high-temperature boundary between metamorphic and igneous rocks.	4.4
minor elements	Those that occur in concentrations <1%, >0.1%	3.7
Moho / Mohorovicic discontinuity	The boundary between the crust and mantle. Averages at 5-7km under oceans, (with little variation); and 35-40km under continents, where it is much more variable. The thickness of the Moho is about 1.5km, a very sharp boundary on Earth-size scales.	1.07
moment of inertia	A fundamental property of a rotating body, which depends on the internal distribution of mass.	1.1
momentum	If a body mass M moves in a straight line at velocity v, it has an momentum of M x v	1.1

Term	Definition	Section
Monte Carlo inversion method	A statistical means of estimating density with depth. Several million random density models were generated by computer. These were tested against known geophysical quantities, such as mass, moment of inertia and seismic-wave velocity. The model is adjusted until it fits the observed geophysical data.	1.1
MORB	Mid Ocean Ridge Basalt (cf OIB, IAB) (May occasionally be P-MORB (plume-linked) or T-MORB (transitional))	3.5
movement vectors	A vector has both magnitude and direction. If 2 (or more!) hotspots are used to calculate the movement of the Pacific plate and give the same answer, then it can be assumed that the hot spots were stationary over the time period considered.	2.2
mudstone	Aluminium-rich sediments, with massive or non-foliated appearance	4.4
Nafe-Drake curve	A plot of density v P-wave velocity, such that given a P-wave velocity, a (range of) densities can be found, then compared with the densities of known materials – so (roughly!) identify the rock.	1.11
neutron capture	The creation of heavier elements by the combination of existent nuclei with 'free' neutrons released by earlier reactions.	1.04
nucleosynthesis	the creation of elements by fusion in a star.	1.04
oblate spheroid	The shape of the Earth, which has a polar radius of that is about 21.5km less than the equatorial radius	1.08
oceanic plate	A plate which contains primarily oceanic crust and mantle in its lithosphere	2.5
OIB	Ocean Island Basalts (cf MORB, IAB)	3.7
olivine nodules	Pieces of olivine-rich material (>80% olivine) found as xenoliths in the basaltic lavas of oceanic islands. They are thought to have been derived directly from the upper mantle, by being torn away from the walls of magma conduits as magma rose to the surface	1.11
Oort Cloud	A zone 10 000 – 100 000 AU from the Sun, wherein comets usually reside	1.02
ophiolite complex	A large region of the Earth's crust consisting of a specific layered structure of characteristic rocks. The sequence is that of a thin layer of sedimentary rock overlying lavas, dykes and gabbro, which in turn overlie peridotite. They are *interpreted* as fragments of ancient oceanic lithosphere, which became trapped between colliding continents. They occur in linear belts, that sometimes run parallel with major mountain chains.	3.2
ophiolites	oceanic crust preserved on the continents	2.4
ophiolites (or ophiolite sequences)	Sections through the oceanic crust and upper mantle that have been uplifted and exposed at the Earth's surface by being thrust onto land (e.g. in Cyprus and the Oman).	1.11
ordinary chondrites	The most abundant type of meteorite	1.04
original heat	(C19th). The Earth formed from a molten ball and has been cooling ever since (from its original heat).	1.03
orthoclase ($KAlSi_3O_8$)	An alkali feldspar	3.2
orthopyroxene	Low-Ca pyroxene	3.2
orthopyroxene ($(Mg,Fe)_2Si_2O_6$)	A pyroxene containing no calcium. So called, because it forms crystals with 3 symmetry axes at right-angles (*ortho* gonal to each other). Orthopyroxenes form a solid-state series between end-members enstatite and ferrosilite.	3.2
outer planets	The lower-density planets, Jupiter, Saturn, Uranus and Neptune – but not Pluto.	1.02
overlap basin	A <basin> that often develops between overlapping spreading ridges.	2.3

Term	Definition	Section
overlapping spreading centre	A site on the oceanic ridge, where the axial crest region gradually dies away and a new ridge segment begins to build up. It is marked by offsets in the ridge.	2.3
palaeolatitude	The historical latitude of a rock, i.e. its latitude at time of formation.	2.2
palaeopole	The location of the 'fossil magnetic pole'; the position of the pole if the continent (from which a sample comes) has not moved!.	2.2
parental magma	That that is the most primitive, in a range of lavas that define a liquid line of descent.	3.6
partial ionic substitution	If the size difference between ionic radii is >15%, then an overall mineral structure will be distorted if substitution occurs, and total substitution is not possible. Compositional variation does not extend continuously or completely between end members.	3.2
partial melting equation	A mathematical model of how the concentration of a trace element in a partial melt reflects: o The concentration of that trace element in the source region (Co) o the amount of partial melting (F) o the mineralogy of the residual solid (through its control of the value of the bulk partition coefficient D) o $C_l = Co / (D + (1 - D)F$	3.7
partition coefficient (= distribution coefficient)	The constant of proportionality. For trace minerals in a rock, it is defined as K_D = (concentration in a given mineral) / (concentration in a coexisting liquid) = C_c/C_l	3.7
passive margin	A continental margin that is seismically and volcanically inactive. The magnetic stripes of the ocean sea floor are complete between the mid-ocean ridge and the continental border, and run its length. (cf active margin)	2.2
peridotite	Ultrabasic rock , SiO_2 < 45%	4.1
peridotite	A rock containing at least 40% olivine	3.2
peridotite nodules	Composed of >= 90% olivine and pyroxene, they occur as rounded lumps of hard, dense, crystalline rock. Some show a granular texture, others a sheared texture. The sheared texture is a result of the rock having been deformed by flow within the mantle.	3.2
perovskite	A phase of olivine. At pressures and temperatures corresponding to a depth of 670 km in the Earth, spinel transforms to an even-higher pressure form, perovskite, (and residual MgO) – another phase change, and another 10% increase in density.	1.11
petrological model	An empirical model of rock formation	2.3
petrological Moho	The border between unlayered peridotite (considered part of the mantle) and layered peridotite (considered part of the crust). There is no seismic discontinuity across it; the petrological Moho is distinct from the seismic Moho. In the petrological model, this defines the base of the crust.	2.3
petrological Moho (cf Seismic Moho)	The boundary between unlayered and layered peridotite, which petrologically distinguishes mantle from crust.	3.2
petrological types	The 6 classes of rock, of increasing metamorphism	1.04
petrology	The study of the composition and structure of rocks	3.2
pfr: ahh!	Plate forces and resistance (keep 'em together!)	2.6
pfr: Bending resistance	(lithospheric) The resistance experienced by the plate as it flexes to descend into the mantle.	2.6
pfr: Colliding resistance	(lithospheric) (Destructive margin) This force is experienced by both plates, in equal magnitude but in opposite directions, as a resistance to collision.	2.6

Term	Definition	Section
pfr: Continental drag	(lithospheric) As continental lithosphere is thicker than oceanic, it has a 'keel' of lithospheric material. Additionally, the low-velocity zone is poorly-developed, or absent, under older parts of the continents. Both of these are additional resistive forces acting under continental lithosphere (so need be *added* to the oceanic drag for the total resistive force acting on the base of a continental plate).	2.6
pfr: Hot-spot push	(lithospheric) The force of rising mantle material. It is negligible when far from a plate margin (Pacific hot-spots), but may add to the forces pushing the plates apart when located on a constructive margin, such as Iceland.	2.6
pfr: negative buoyancy force	(?) This is the gravitational force that tries to pull the *whole* cold oceanic slab *vertically* down into the asthenosphere. (The component that actually acts on the plates at the trench is the slab-pull force.)	2.6
pfr: Oceanic drag	(lithospheric) This is the retardation, or resistance, between lithospheric plate and asthenosphere, as the plate is moving faster than the underlying asthenosphere.	2.6
pfr: Overriding plate resistance	(lithospheric) (Destructive margin) The frictional resistance of the overriding plate, as the descending slab passes under it.	2.6
pfr: ridge resistance	(?) There is a frictional resistance to the ridge-push force, which is this ridge resistance. This is indicated by the shallow earthquakes experienced at the ridge. (its direction is up the slope of the ridge)	2.6
pfr: Ridge-Push force	(lithospheric) The ridge push force is a horizontal force, away from the ridge, due to gravity (as the ridge is 2-3km above the surrounding ocean floor, and consists of buoyant lighter material).	2.6
pfr: Slab resistance	(lithospheric) o This is the resistance to the slab-pull force, due to both o Drag on both upper and lower surfaces of the descending plate, and o Chemical and phase changes that are taking place in the slab as it experiences greater pressures and temperatures	2.6
pfr: Slab-pull force	(lithospheric) This is the pull of the cold slab into the hot mantle, at the destructive margin. It is the component of the negative buoyancy force that actually acts on the plate. It is related to the gravity drive, and is greater for a steeper descent of plate into mantle.	2.6
pfr: Transform Fault Resistance	(lithospheric) At the side/end of a ridge is a conservative plate margin, often a transform fault. Here, the plates move against each other, and experience a resistive force, which is this transform fault resistance.	2.6
pfr: Trench Suction	(lithospheric) This force acts on the overriding plate, pulling it towards the trench.	2.6
phase	o A substance with a particular chemical composition and molecular structure. OR o something that differs chemically and/or physically from the rest of the system being considered. o (Olivine and quartz are two phases, as they have different structure and composition; but carbon and diamond are also 2 phases, though only their structure differs)	3.3
phase boundaries	o The interfaces between stability fields in a phase diagram. o It gives the only conditions under which two phases can co-exist in equilibrium.	3.3

Term	Definition	Section
phase diagram	Generally, phase diagrams illustrate the conditions of temperature, pressure and composition, under which different phases exist. (usually, one of these 3 is kept constant, and the other 2 are plotted against each other). o It illustrates the stability fields of (e.g. three) different phases in a system. Solid lines that mark the boundaries of stability fields are called phase boundaries.	3.3
phenocrysts	Crystals that cool in lava. Plagioclase and pyroxene phenocrysts can be seen in basalts and andesites.	3.6
photosphere	The sharp-edged visible surface of the Sun, a layer ~500km thick (<0.1% of the solar radius). Temperature around 6000K	1.04
plagioclase feldspar series	The chemical variations due to substitution between albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$). This is a solid-solution series.	3.2
plagioclase peridotite	A peridotite nodule found in a basalt, that contains plagioclase! (olivine, pyroxene, and minor plagioclase feldspar). They are unusual, but can be found in New Zealand. (Spinel peridotites more common)	3.2
planetary embryos	The result of planetesimals growing and merging, mass range 10e22 – 10e23kg; Moon - Mercury size	1.03
planetesimals	Rocky bodies that accreted out of the cooling solar nebula, diameter up to ~ 10km (mass ~ 10e15kg)	1.03
planets	Formed by collision and coalescence of planetary embryos	1.03
plastic (cf elastic)	The property of a material that, when subjected to stress, remains permanently deformed.	1.05
plate boundary	Constructive, destructive or conservative - or a combination!	2.2
plate model	A model to explain the base, and thickness, of the lithosphere. It proposes that lithosphere with a constant plate thickness is produced at the oceanic ridge, and the temperature below the lithosphere plate corresponds to the temperature of formation. (cf boundary-layer model)	1.12
plate-tectonic lithosphere	The layer that 'translates coherently' (!!) during the major horizontal motions of plate tectonic processes.	1.13
plutons	Large bodies of magma, cooled slowly at depth	2.3
pm	picometre = 10^{-12} m	3.2
P-MORB	MORB linked to plumes (so intermediate between MORB and OIB) (cf T-MORI)	3.7
point of rupture	The point at which fault-generated earthquake movement begins, i.e. it focus.	1.05
polarised seismic waves	Waves aligned in a particular direction.	1.14
polymorphs	Chemically-identical substances with different structures (diamond and graphite are polymorphs of carbon)	3.3
potential temperature	The temperature extrapolated from any depth in the convecting subsolidus mantle, along the adiabatic gradient to the Earth's surface. (i.e. the temperature that a packet of mantle material would have when it reached the surface, if it rose as a solid and did not cross the solidus and begin to melt) As we know that the mantle melts below a spreading ridge, the potential temperature of the mantle must be *at least* the solidus temperature of peridotite, at the surface. From experimentation, this value is around 1100 degrees C.	3.5
Pratt's hypothesis of isostasy	Proposes that the columns all have different, but uniform, densities down to the level of compensation. Column height is thus simply a function of density.	1.08

Term	Definition	Section
primary magma	One that has been produced by partial melting of some source rock, such as lherzolite. They are rare; common found magmas are the result of processes acting on (and so modified the composition of) primary magmas.	3.6
primary mineral	A mineral that has crystallised from a magma.	3.7
primitive magma	Magma close in composition to primary magmas (relatively).	3.6
primordial atmosphere	The atmosphere of a planet, present at its formation	1.03
propagating rift	This is a change in direction of a spreading ridge, due to the propagation of a new ridge at the expense of the old. Whilst both are active for some time, the new gradually takes over from the old. The magnetic anomaly pattern between the two shows acute angles and abrupt direction change.	2.4
Pu'u O'o	The most recent series of eruptions from Hawaii's Kilauea volcano.	3.6
P-wave	ComPressional body wave, whose movement is in the direction of the wave.	1.05
P-wave shadow zone	A broad ring shaped zone, limited by epicentral angles of 103° and 142°, where no direct or refracted P-waves can be received. (Some P-wave do emerge in the P-wave shadow zone – but not waves of the 'mantle – fluid core – mantle' type.)	1.07
pyroclastic rock	Fragmental rock formed by explosive eruptions	2.3
pyrope	A member of the garnet group	3.3
quenching method	An experimental method that involves very rapid cooling (i.e. quenching)	3.3
radiation pattern	The pattern of first motions that arrive at seismometers around the earthquake epicentre. For P-waves, this is a 4-lobe pattern, whereas for S-waves, it is a 2-lobe pattern – assuming that the earthquake has a single-couple source.	1.05
rainout model (for the formation of the Earth's core)	For all or much of its growing life, Earth consisted of an emulsion of liquid iron and liquid silicates. Iron would have accumulated in clouds of droplets, with diameter about 1cm. These droplets would have dropped toward the core, due to their greater density.	1.03
Rayleigh number (Ra) Ra = a?Tgd3? / ??	A quantitative explanation of convection, that depends on the combined properties of a fluid. It is dependent on: a volume coefficient of thermal expansion, ?T temperature difference, g gravitational acceleration , d height of fluid layer, ? thermal diffusivity, ? dynamic viscosity, ? density	1.14
Rayleigh waves	Surface waves with a vertical, elliptical movement of particles, (rather like and ocean wave) Centred on the earthquake's epicentre.	1.05
record section	seismic data record, where the record from each (of many) seismometers is plotted at its appropriate epicentral distance, on the same <<<plot>>>.	1.06
red giant	The result of a contraction of a star that raises its internal temperature to around 10e8, at which fusion into heavier elements can begin, in the centre. The outer layers will expand and cool, resulting in this highly luminous variety of star.	1.04
reduced heat flow	Heat flow coming from underlying rocks and mantle, in which there is no radiogenic heat. <<<check>>>	1.12
reduced record section	A record section whose vertical scale has been adjusted to plot t – (x/v1) against x. An advantage of reduced record sections is that travel-time and amplitude data are displayed together.	1.06

Term	Definition	Section
reduced time-distance graphs	Time-distance graphs where the plot is of t – (x/v1) against x. (instead of time v distance (t v x), were v1 is the seismic velocity of the direct wave in the upper layer – although other velocities are sometimes chosen for convenience, on particular cases) The main use of reduced time-distance graphs is for graphs with manageable scales.	1.06
reduction velocity	<<<no idea! p p92 implies it is the same, i.e. 'the velocity of the direct wave' >>>	1.06
refractory	Substances with high vaporisation temperatures (opposite of volatile)	1.03
retrograde	The rotation of Venus, Uranus and Pluto, compared to the rest of the Solar System. If their rotation is "clockwise" – then that of the other planets (and orbiting bodies) is "anti-clockwise".	1.02
Richter Scale	All earthquake magnitude scales based on our given equation (p68!), that are logarithmic. Note that there is no "The" Richter scale.	1.05
rigidity modulus	shear modulus	1.06
rock deformation		2.3
r-process	Rapid neutron capture, as occurs in a supernova explosion.	1.04
Satellite laser ranging	Used to measure modern plate movements	2.2
sea-floor spreading	The theory that the ocean floor is created at the spreading (accretionary	2.2
seamount	a volcano on the ocean floor	1.13
second arrival	If the first arrival is a refracted wave, then the time of arrival of the first direct wave. (And, if the first arrival is a direct wave, then the time of arrival of the first refracted wave.)	1.06
secondary atmosphere	An atmosphere of a planet gained after the planet's formation, for example from outgassing from its interior.	1.03
secondary waves	Waves emitted as the 'main' wave travels along a discontinuity boundary. Some are refracted back upwards into the upper layer.	1.06
seismic arrays	Clusters of seismic stations, often arranged in geometric patterns. (e.g. The Taiwanese arrangement of 37 stations in 3 rings)	1.05
seismic lithosphere	The high(er)-velocity lid overlying the low(er)-velocity zone (LVZ)	1.13
seismic Moho	The 'normal' definition of the Moho, the discontinuity in seismic velocities. (cf petrological Moho.)	2.3
seismic Moho (cf petrological Moho)	The seismically-defined boundary between mantle and crust. (Petrologically, this lies between gabbro, and layered peridotite)	3.2
Seismic reflection	P-waves from an energy source at the Earth's surface are reflected at subsurface discontinuities and, when they return to the surface, are recorded by detectors. Geometry allows the plot of a time-distance graph, whose plot is not a straight line (as it was for the refraction method), but is a curve (hyperbola)	1.06
seismic refraction method	Involves the initiation of seismic waves at one point, then seeing how long they take to get to a series of observation points.	1.06
Seismic tomography	The study of the Earth's structure, using large numbers of seismic waves criss-crossing as they pass through the planet.	1.07
seismic waves	A vibration or shock wave, resulting from earth movements (not necessarily caused by an earthquake) All seismic waves are elastic.	1.05
seismically active margins	One of two general types of continental margin, where oceanic crust is being subducted (e.g. around the Pacific).These are sites of large isostatic gravity anomalies.	1.09
seismogenic lithosphere	The layer at which earthquakes can take place.	1.13

Term	Definition	Section
seismogram	The output of a seismic recording system (seismograph), e.g. a paper or film record, showing the seismic wiggle traces, usually for a single shot spread. In refraction surveys, many shots into one spread may be summed by a signal-enhancement seismograph to produce a single record. When records are processed they can be placed side by side along a profile to form a 'seismic section'.	1.05
seismology	The study of elastic (seismic) waves and how they are produced. Global seismology is the study of seismic waves from earthquakes (and to a lesser extent nuclear explosions), to investigate the structure of and processes within the Earth. In exploration seismology, artificially generated seismic waves are used in the search for resources (e.g. hydrocarbons, etc.) and the study of the Earth's surface and near-surface. Planetary seismology is the use of seismic waves to investigate the structure of and processes within planets and natural satellites in the solar system.	1.05
seismometer	1. A device used to detect seismic waves originating from earthquakes. 2. In exploration seismology, a geophone.	1.05
self-compression	The increase in density of a (chemically-equivalent) material at depth, due to the weight of the over-lying material. This process converts gravitational energy into heat energy.	1.02
serpentine	A mineral (often) resulting from the reaction of olivine and water (so may be found in ophiolite sequences, for example)	3.2
serpentinite	A serpentine-rich rock	3.2
shallow earthquake	depth of focus = 0-70 km	1.05
shear modulus <<<G or ?>>> (also rigidity modulus) (an elastic modulus)	tangential force per unit area / angular deformation	1.06
short-lived half-life	½ life < 1 000 000 years	1.03
siderophile elements	Elements that prefer to exist as metals (or metal alloys). (cf lithophile, chalcophile) These tend to be concentrated in the core, e.g. Ni, Pd and Rh.	1.04
silicate (tetrahedron)	Any of a group of substances containing negative ions composed of silicon and oxygen. The silicates are a very extensive group and natural silicates form the major component of most rocks (see silicate minerals). The basic structural unit is the tetrahedral SiO4 group. This may occur as a simple discrete SiO44- anion as in the orthosilicates, e.g. phenacite (Be2SiO4) and willemite (Zn2SiO4). Many larger silicate species are also found. These are composed of SiO4 tetrahedra linked by sharing oxygen atoms as in the pyrosilicates, Si2O76-, e.g. Sc2Si2O7. The linking can extend to such forms as bentonite, BaTiSi3O9, or alternatively infinite chain anions, which are single strand (pyroxenes) or double strand (amphiboles). Spodumene, LiAl(SiO3)2, is a pyroxene and the asbestos minerals are amphiboles. Large two-dimensional sheets are also possible, as in the various micas, and the linking can extend to full three-dimensional framework structures, often with substituted trivalent atoms in the lattice. The zeolites are examples of this.	3.2
single-couple source (Type I source) (cf double-couple source)	The source of a fault-generated earthquake that has such smooth fault planes, that all movement is in the same direction, along that fault plane. The P-wave radiation pattern is 4-lobe, but the S-wave radiation pattern is 2-lobe.	1.05

Term	Definition	Section
slate	Low-grade, fine-grained regionally-metamorphosed rock. It has a slaty cleavage, due to the alignment of minerals (such as muscovite) resulting from tectonic compressive deformation. A slate is the result of a small in increase in temperature and pressure, acting on a mudstone.	4.4
sodium feldspar ($NaAlSi_3O_8$)	The one common component of both plagioclase and alkali feldspars	3.2
solar nebula	A flattened rotating disc surrounding the Sun. It contains 1-2% of the original gas and dust from the interstellar cloud from which it was formed 5 Ga ago. On cooling, it formed planetesimals, planetary embryos, then planets.	1.03
Solar System	The Sun, the planets, and other bodies revolving around it	1.02
solid-solution series	All possible variants of minerals that have a range of chemical compositions, allowed by ionic substitution.	3.2
solid-state creep	A process by which solid material can slowly flow, due to high pressures and over long time-scales.	1.07
solidus	The curve on a phase diagram below which the system is entirely solid	3.3
specific heat capacity	amount of energy required to raise the temperature of 1kg of a substance through 1K.	1.03
speed of light	3.0 x 10e5 km s^{-1}	1.02
spinel	A phase of olivine. At pressures and temperatures corresponding to a depth of 400km in the Earth, olivine transforms into spinel (a form where the atoms are more closely packed), which has a density 10% greater than that of olivine.	1.11
spinel group	This is a group of non-silicate minerals. Loosely defined by MOR_2O_3 , (or, MR_2O_4) where o M is a divalent cation (e.g. Mg^{2+}) and o R is a trivalent cation (e.g. Fe^{3+}) Important end-members in this diverse group are spinel ($MgAl_2O_4$), magnetite ($Fe^{2+}(Fe^{3+})_2O_4$) and chromite. ($Fe^{2+}Cr_2O_4$)	3.2
spinel peridotite	A peridotite nodule, found in a basalt, that contains spinel (a Mg-Al oxide). Both sheared and granular varieties are common. They are the dominant type of mantle xenolith in basalt (though plagioclase peridotites are also found).	3.2
spreading axis	Constructive plate margin (see spreading centre)	2.3
spreading centre	Location of magma intrusions on a spreading axis.	2.3
spreading rate	The movement of one plate away from another (at a constructive plate boundary). This is a relative rate of movement, and assumes that the rate of spread is equal on either side of the ridge. (cf half-spreading rate)	2.2
spreading ridge	Constructive plate margin	2.3
s-process	Slow neutron capture, as occurs within a star's interior.	1.04
stability field	The area in a phase diagram where a particular substance is stable.	3.3
stable junction	A triple junction that can maintain its shape over geological time, such as an RRR junction.	2.3
standard model	For the formation of the Sun and planets. The Sun formed around 5Ga ago as a result of gravitational instability in a dense, rotating interstellar molecular cloud, leading to the Sun and the solar nebula. The planets subsequently formed by the coalescence of material within the solar nebula, from planetesimals to planetary embryos then planets..	1.03
strain (distort)	Elastic deformation, or distortion, produced by applied stress. strain = (change in volume) / (original volume)	1.05

Term	Definition	Section
stress forces	Forces applied to rock that cause strain. Force/Area = F/A in Nm^{-2}	1.05
subcritical reflections	These are weak reflected waves, detected within the critical distance (as they strike the boundary between the layers at < the critical angle)	1.06
subduction	The process in which tectonic plates of oceanic lithosphere descend ba	2.3
subduction zone	Destructive plate boundary	2.3
subsolidus	The area in a phase diagram below the solidus (where the system is entirely solid)	3.3
super- adiabatic temperature gradient	The gradient of temperature increase with self-compression and other factors, leading to a greater increase than due to only self-compression.	1.1
supercritical reflections	These are the reflected waves beyond the critical distance, whose strength (or amplitude) increases rapidly for distances >SC. (critical distance) They may be the strongest waves to arrive at detectors beyond SC, although they arrive after both direct and refracted waves.	1.06
supernova explosion	The death of a large star, with a metallic core. All it nuclear fuel has been used up, so the star collapses into itself, raising temperatures to at least 10e9K. The outer layer initially collapses inwards, but is then thrown out – in a supernova explosion. This both produces more heavy elements (cf r-process), and distributes the existent heavy elements through a surrounding region, many light-years across.	1.04
surface waves	seismic waves that are restricted to the vicinity of the Earth's surface. e.g. Love waves and Rayleigh waves. Centred on the earthquake's focus.	1.05
surface-wave magnitude	Based on the maximum amplitude of the horizontal component of surface waves, usually Rayleigh waves, with period 17-23s. Particularly useful for shallow earthquakes of focal depth <50km and epicentral angle > 20°.	1.05
S-wave shadow zone	A 'cap' shaped zone from an epicentral angle of 103° on the opposite side of the Earth, in which no (direct or refracted) S-waves can be received. (Some reflected S-waves may be received in the S-wave shadow zone.)	1.07
S-waves	TranSverse, or Shear body wave, with movement at right-angles to the direction of the wave, either vertical or horizontal (or both)	1.05
system	Any part of the Universe that we wish to isolate!	3.3
ternary	Something with 3 components - like a ternary eutectic system	3.4
ternary eutectic	The point in a ternary diagram, where the three cotectics meet. At this point, the 3 minerals can coexist, with a liquid of specific composition.	3.6
Terrain correction (?4g)	Surrounding hill and valleys affect measured gravity. The terrain correction is derived by summing the effect of all hills and valleys in the neighbourhood of each gravity site, using standard tables.	1.08
thermal conductivity (k) (unit Wm-1K-1)	the amount of heat conducted per second through an area 1m2 , when the temperature gradient is 1Km-1 perpendicular to that area.	1.12
thermal lithosphere (cf conduction layer)	The layer in which heat is transferred manly by conduction – the underlying asthenosphere being the layer in which heat is transferred largely by convection	1.13
thrust faults	Faults that allow thickening by stacking	2.3
tie-line	A horizontal line on a phase diagram that links (e.g.) compositions of phases that co-exit at particular temperatures. I.e. a line between phases that coexist at any one time.	3.4

Term	Definition	Section
T-MORI	transitional MORB (so intermediate between MORB and OIB) (cf P-MORI)	3.7
trace elements	Elements that occur in tiny amounts in a material, with concentrations (normally) less than 1000ppm. (cf major elements, >1%, minor elements, 0.1-1%)	3.7
trace-element discriminant diagram	A plot of a trace element, against its ratio with another trace element (e.g. Zr against Zr/Y). (note, it has logarithmic scales) The data defines two areas, for OIB and MORB, so separates basalts on the basis of certain trace-element ratios.	3.7
transform faults	A type of strike-slip fault in an ocean, occurring at the boundaries of lithospheric plates, in which the direction of movement of the crustal blocks is reversed (or 'transformed') in comparison with a strike-slip fault on land. For example, at mid-ocean ridges the offset between adjacent ridge sections is a transform fault; where the displacement is dextral (right lateral) the motion, due to spreading, is left lateral, and vice versa. Generally, transform faults occur at right angles to the ridge itself and indicate the direction of spreading. The active transform fault extends into an inactive fracture zone.	2.3
trans-Himalayan batholith	Emplaced into the southern margin of the Asian Plate, just north of the suture between Asia and India. It is a vast igneous arc, >3000km long and 50km wide, made up of plutons of granites, granodiorites, diorites and a small proportion of gabbros. The age range is from 110Ma - 40Ma. They were emplaced during subduction of oceanic lithosphere, so magmatism stopped when collision occurred, 40Ma ago. It is a pre-collision example of magmatism at an active continental margin. (cf High Himalayan leucogranites)	
transition zone	The region between 400 km and 670 km. At depths of 400 km and 670 km <<< or “between?>>> the mineral olivine, which is the main constituent of the mantle, undergoes phase changes – it remains olivine, but its crystallographic structure changes. The transition zone is thus a region of change between ‘normal’ olivine in the upper mantle, and the final, high-pressure form, in the lower mantle.	1.07
trench suction force	A popular theory to explain the extension in back-arc basins. This is a force that pulls the overriding plate towards the trench, thus subjecting the back-arc to extension.	2.3
trench-arc complex	Destructive plate boundary	2.3
triangular composition diagram	A triangular plot of 3 (chemical!) end-members, between which some (partial or complete) ionic substitution can occur	3.2
triple junction	A locality where 3 plates are in contact. (Ridge = R, Trench = T, transform Fault = F. Hence, RRR, FFR….)	2.3
triple junction	Caused when a constructive (or divergent) plate margin forms in continental crust. As the crust stretches, the rocks fail in a brittle manner and fracture, resulting in faults with extensional character. These faults develop into long, narrow zones, the zones full of subsided and tilted crustal rocks that form terraces. This is a rift valley, alternatively termed 'graben'.	2.5
triple point	o A point at which 3 phases on a phase diagram are in equilibrium; i.e. can exist stably together. o For pure water, it is 0.0075 degrees C and 611 Nm^{-2}.	3.3
troilite	FeS, found in small quantities in some meteorites.	1.11

Term	Definition	Section
true plate motion	See absolute plate motion - the movement of a plate with respect to a fixed frame of reference.	2.2
true polar wander	The difference between the polar wander paths, as predicted over a given time within the hot spot reference frame (the apparent polar wander), and the measured wander from magnetic data.	2.2
turbulent convection	Irregular convection, that develops (from Bénard cells) when the fluid is subject to greater heating.	1.14
two-way travel time	The time taken for the wave to travel to the appropriate depth and back to the surface. A record section may be thus labelled, whose horizontal axis is distance and the vertical is depth, but with the latter labelled as two-way travel time.	1.06
Type I source	single-couple source	1.05
Type II source	double-couple source	1.05
ultrabasic rock	silicic content very low, SiO_2 < 45% e.g. peridotite	4.1
universal gravitation constant (G)	G = 6.672 x 10e-11 Nm^2kg^{-2}	1.08
Universe	The whole of existing matter, energy and space	1.02
unstable junction	A triple junction that *cannot* maintain its shape over geological time, such as an FFF junction.	2.3
upper mantle	Comprises the subcrustal lithosphere (that below the Moho), the asthenosphere, and that part of the mantle between the base of the asthenosphere and the 400km discontinuity.	1.07
velocity anisotropy	The dependence of seismic velocity on direction	1.14
Very Long Baseline Interferometry (VLBI)	Used to measure modern plate movements	2.2
Vine and Matthews hypothesis	Links sea-floor spreading to magnetic reversal stripes, and lays the foundations for plate tectonics.	2.2
volatiles	Substances (elements or compounds) which are easily vaporised (at low temperatures). (opposite of refractory)	1.03
volume coefficient of thermal expansion a	(or cubic expansivity) of a substance is the increase in volume per unit increase in temperature of that substance, expressed as a fraction of the original volume.	1.14
Wadati-Benioff zone	See Benioff Zone.	1.05
wave velocity	square root of (elastic modulus/density) (by experiment)	1.06
white dwarf	The result of a star that has 'used up' all its nuclear energy supply, so contracted to a 'dead' compact object.	1.04
whole-mantle convection	A model of mantle convection in which convection cells extend from the core-mantle boundary to the base of the lithosphere. <<< it is invalid??>>>	1.14
wollastonite ($Ca_2Si_2O_6$)	This is not a pyroxene (as the large Ca^{2+} ions result in a different structure). However, it is often considered a surrogate end-member when considering chemical compositions of pyroxenes. (e.g. diopside can be described as 50% enstatite, 50% wollastonite).	3.2
xenolith	Foreign rock; an inclusion or enclave of a pre-existing rock into an igneous rock.	3.2
xenoliths	A 'foreign body' in rock; for example, pieces of the lower crust broken off and brought to the surface by rising magma.	1.11
Young's modulus (an elastic modulus)	The ratio of longitudinal stress (force F divided by area A, i.e. stress = F/A) to longitudinal strain (change in length deltaL divided by original length L, i.e deltaL/L) in the presence of lateral strain: E = (F/A)/deltaLL/L). If there were no lateral strain, Young's modulus would be equal to the axial modulus.	1.06