Basics of Energy - Definitions

Energy

A measurement of matter based on the capacity for matter to perform tasks (*do things, i.e. Work*) to other forms of matter

Kinetic Energy

The energy matter based on the movement of matter in space as *heat* or *speed* (velocity)

Potential Energy

The stored energy of matter based on the physical connections, location, or interaction with other forms of matter

1

Basics of Energy – Math Stuff

Kinetic & Potential Energy

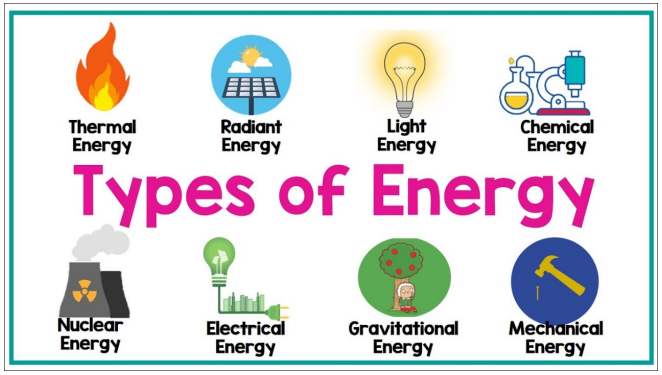
$$KE = \frac{1}{2} m V^2 \qquad PE = mgh$$

KE = Kinetic Energy **h** = Height (*m*) **m** = Mass (*g*)
PE = Potential Energy **g** Force **v** = Velocity (*m/s*)

2

Using Energy – Work and Power

3



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Forms of Energy

Thermal Energy

Heat, the energy given off due to the interaction of different forms matter, which causes a change in speed (*i.e. temperature*)

Radiant + Light Energy

Energy flow through the movement of light in space, normally due to heat (*infrared radiation*), nuclear energy (*nuclear radiation*), of visible light (*light energy*)

5

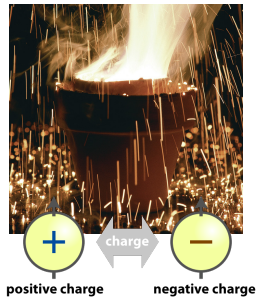
Forms of Energy

Chemical Energy

Energy given off due to the change of the physical connections/structure of matter.

Nuclear Energy

Energy given off due to the breakdown of atoms themselves, the smallest form of matter



Electrical Energy

Energy flow due to the movement of electrons, the smallest fundamental parts of an atom

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Forms of Energy

Gravitational Energy

Energy given off by the interaction of mass with the spin/rotation of the earth

Mechanical Energy

Energy flow due to the movement and interaction (*collisions*) of particles directly with each other

7

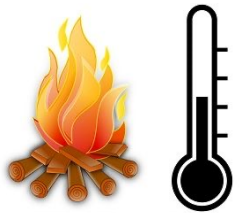
Heat and Temperature

Heat

Energy that is transferred from one object to another based on the difference in temperature between the two objects
[*Units – Joules, J; Calories, Cal*]
1cal = 4.184J, 1kcal = 4.184kJ

Temperature

The speed that particles travel in space based on their internal energy (*heat*)
[*Units - Celsius, C°; Kelvin, K*]
0K = Absolute Zero (*lowest temp possible*)



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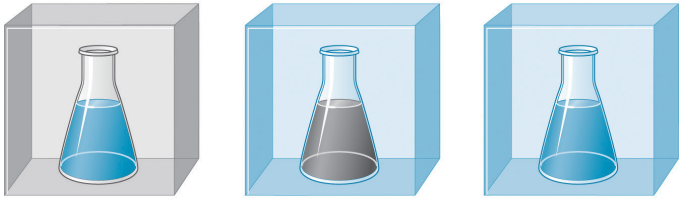
System and Surroundings



System + Surroundings = Universe

The object we are studying in nature

Everything else

System combined with surroundings

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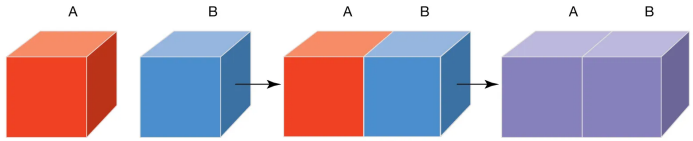
Heat Flow between objects



Block A has a higher temperature than block B.

heat flow

Heat is transferred from the warmer block to the cooler block.

The two blocks are the same temperature and heat flow stops.

Heat always flows from the object with more heat to the object with less heat. Over time the two objects end up having the same level of heat and **temperature**

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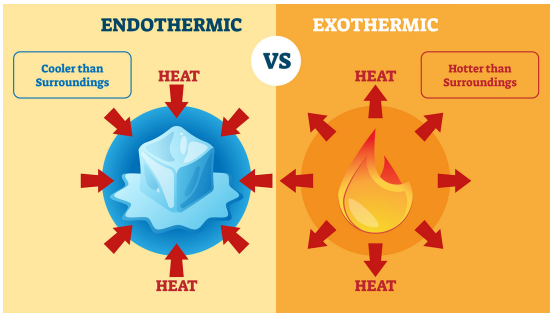
Endothermic and Exothermic Systems

q = +

Endothermic Heat Flow

Heat flows from the surroundings into the system



Exothermic Heat Flow

Heat flows from the system into the surroundings

q = -

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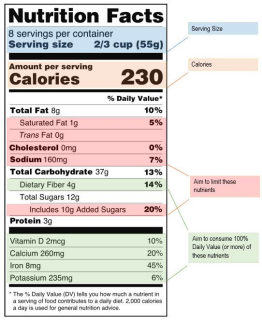
Heat and Energy in Real Life Systems



Nutrition Facts

8 servings per container

Serving size 2/3 cup (55g)

Amount per serving

Calories 230

% Daily Value*

Total Fat 8g 10%

Saturated Fat 1g 5%

Trans Fat 0g

Cholesterol 0mg 0%

Sodium 160mg 7%

Total Carbohydrate 37g 13%

Dietary Fiber 4g 14%

Total Sugars 12g

Includes 10g Added Sugars 20%

Protein 3g

Vitamin D 2mcg 10%

Calcium 260mg 20%

Iron 8mg 45%

Potassium 235mg 6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Serving Size

Calories

Aim to limit these nutrients

Aim to consume 100% Daily Value (or more) of these nutrients

Nutrition Labels give us information about the energy (*heat*) content in food

Calories is the energy content in food in the *imperial system*, where as **Joules** and **kilojoules** (**kJ, 1000J**) are used elsewhere in the world

Calories are measured by determining how much heat is produced when the food is burned in a controlled lab experiment

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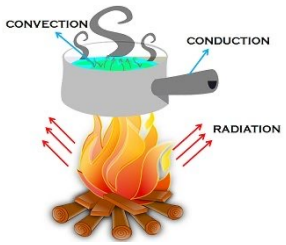
Methods of Heat Flow

Conduction

Heat transfer through two objects directly touching each other.

In *conduction* movement is directly transferred from one material to another. The speed (*temperature*) of the movement is based on the connections within the material being moved and the material's *specific heat value.*



Specific Heat
Energy required to raise 1g of a substance by 1°C

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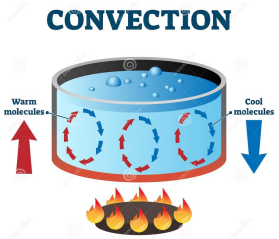
Methods of Heat Flow

Convection

Heat transfer through the moving of liquids or gases in a liquid system (*water, gas, etc*). In convection warmers, less dense fluids rise, while colder more dense fluids sink due to gravity on the earth

Convection Currents are the resulting movement of fluids under the effect of convection in a fluid



Convection Currents
The heat below the pot allows the lower fluids to warm, lower in density, then rise to the top

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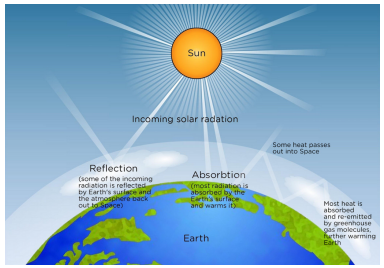
Methods of Heat Flow

Radiation

Heat transfer in space through infrared light waves. The light waves contain energy which can be transferred (*absorbed*) by a surface, reflected into space, or even used to generate electricity in *solar power* applications



Radiation moves best through a vacuum (*space*), and starts to be absorbed in the atmosphere of the planet

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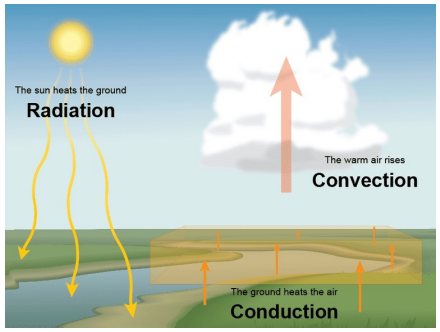
Heat Flow in Nature



Heat Cycle within the Earth System

Air is heated by the ground and water (*conduction*), then the air moves the heat up (*convection*) which is then reheated by the sun (*radiation*) and repeated

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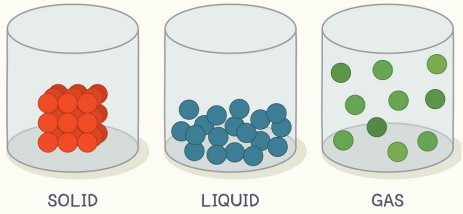
State of Matter

A *state of matter* is a form that matter than take in nature due to matter's particle connections, energy, shape, and density.



Solid
Fixed Volume
Fixed Shape

Liquid
Fixed Volume
Variable Shape

Gas
Variable Volume
Variable Shape

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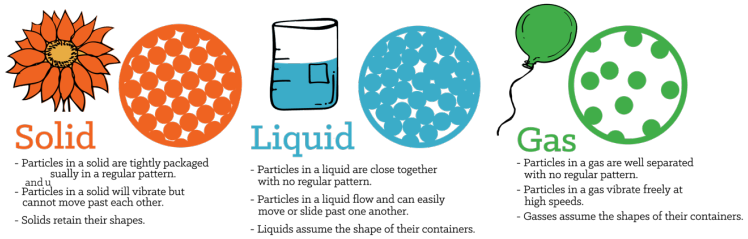
Three States of Matter



The *state of matter* is based on the space between particles (*density*) and the arrangement of the particles (*space*)

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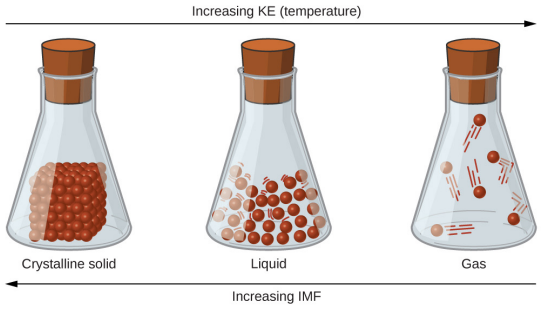
Intermolecular Forces

The connections between particles based on their state of matter



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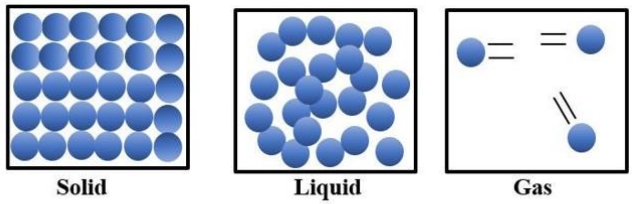
Heat and States of Matter

Kinetic Energy (*heat*) and Speed (*temperature*) are based on state



Solid	Liquid	Gas
High IMF	Mid IMF	Low IMF
Low KE	Mid KE	High KE
Low Temp	Mid Temp	High Temp

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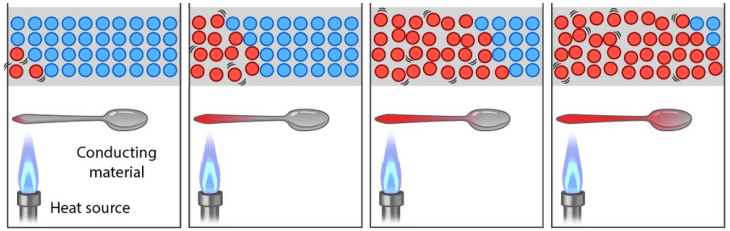
Conduction and Heat Flow

Energy (*heat*) flows from one particle to another in a state of matter due to conduction (*heat transfer due to direct contact*)



Higher energy particles lose energy to lower energy particles in states

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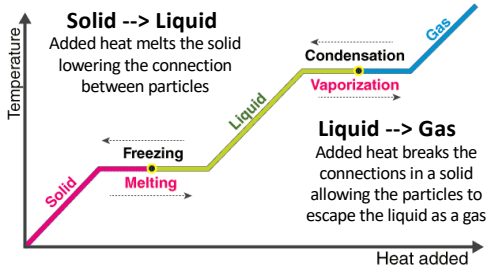
Energy and State Changes

Energy (*heat*) flows between objects until the energy is large enough to change (*break or form*) new connections between particles.



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Earth's Internal Structure

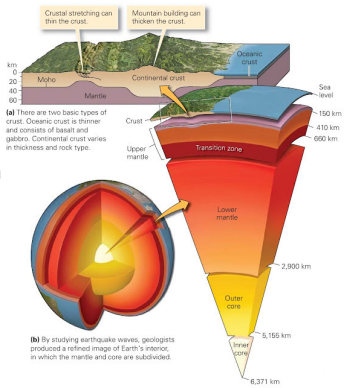
Internal Layers of the Earth

Inner Core

Solid Iron (*Fe*) metallic inner layer at high temperatures approaching the sun

Outer Core

Thick Liquid Iron (*Fe*) and Nickel (*Ni*) layers that flow based on convection currents (*flow based on density*). The outer core produced the *magnetic field* within the earth structure.



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Earth's Internal Structure

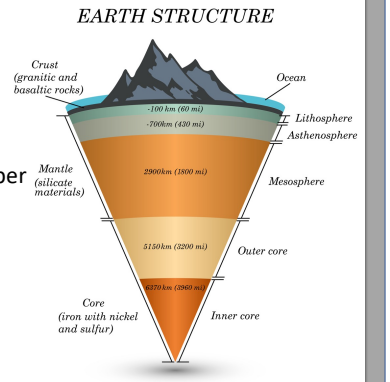
Internal Layers of the Earth

Upper Mantle

Lithosphere, liquid upper layer made of magma made of liquid rock. The upper mantle's magma becomes lava when it leaves the mantle to the crust.

Lower Mantle

Asthenosphere, thicker liquid that supports the upper mantle into the transition to the core. Temp = 4000K



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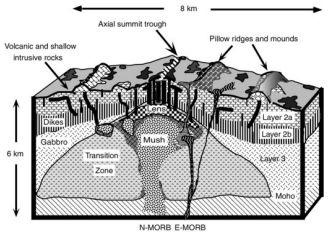
Earth's Internal Structure
Internal Layers of the Earth

Oceanic Crust (*5km Thick*)
Thinner rock layer above the magma below the ocean. The crust structure below the ocean which makes the crust thin due to the pressure of the water

The oceanic crust is theorized to contain an upper sedimentary layer, a middle basaltic volcanic layer, and a lower third layer consisting of gabbroic plutonic rocks.



The oceanic crust is hard to study due to the ocean pushing over the surface. The thin layers under the ocean are in constant change due to the lower magma layers within the earth.

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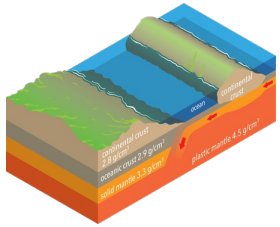
Earth's Internal Structure
Internal Layers of the Earth

Continental Crust (*30 – 50km*)
Thicker crust raising above the oceanic crust that make up the continents of the earth. Due to the accessibility of the continental crust the structure is well known.

The structure of the continental crust consists of Sial rocks, a granite rock with large amounts of aluminum and silicate



The thickness of the continental crust changes dramatically through the earth surface area. Thinner crust regions closer to sea level contain the greatest activity of the crust.

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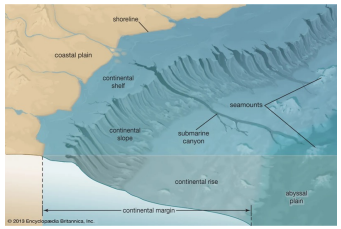
Earth's Internal Structure
Oceanic vs Continental Crust

The continental crust starts out thick near the center of the continental crust then lowers to the *continental shelf*, the place where the continental crust drops below the ocean to meet the continental crust.

The continental shelf separates the continental's **costal plane** and the oceanic's **abyssal plane**



The oceanic and continental crust boundary is an important part of the geological structure of the earth

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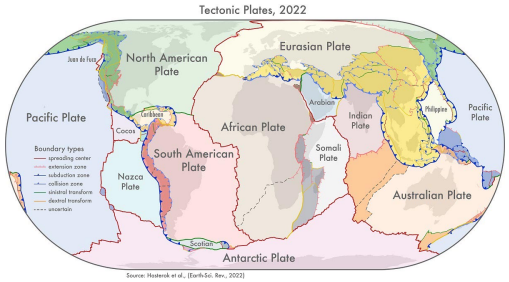
Continental and Oceanic Crust Structure

Tectonic Plates
Sections of the crust that interact with other parts of the crust at plate boundaries.

Plate Boundaries
Splits within the crust where different layers of the crust interact with each other and causing changes in the crust over time.



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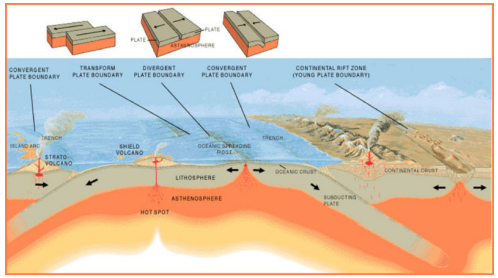
Tectonic Plates and Changes in the Crust

Plate boundaries interact with different types of plate interaction zones. Interaction zones are responsible for geological activity in the earth

The earth is under constant change due to the *continental drift theory*, the movement of plates through changes in the location and orientation of the earth's tectonic plates



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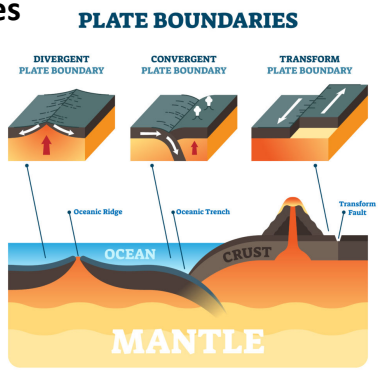
Tectonic Plate Boundaries

At the plate boundaries the plates move relative to each other

All plates on the earth are connected to each other based on the *continental drift* theory

When one plate expands (*divergent boundary*) another plate contracts (*convergent boundary*)

Plates can also slide past each other (*transform boundary*)



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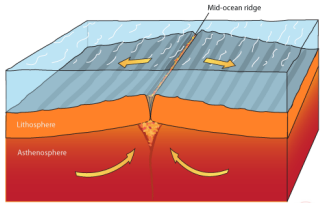
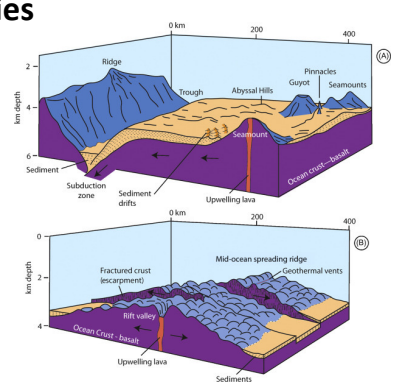
Tectonic Plate Boundaries

Divergent Plate Boundary

Plates separate allowing lava to push up forming an oceanic ridge and volcanic (*lava flow*) activity





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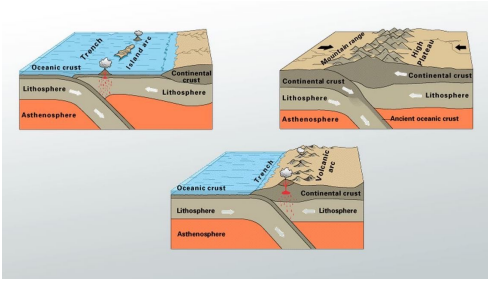
Convergent Plate Boundary

Plates collide at a *subduction zone*. One plate pushes below another plate with the extra crust being absorbed into the lower mantle layer

Oceanic – Oceanic
Ocean trench forms below the water

Ocean – Continent
Volcanos rise by ocean trench on crust

Continent – Continent
Mountain ranges form with high plateau



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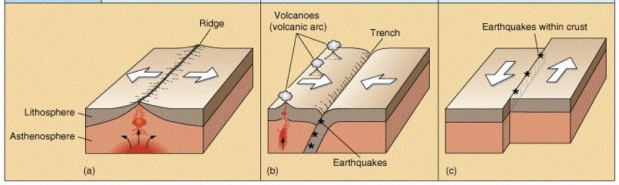
Impacts of Tectonic Plate Boundaries

Tectonic Plates Intersect in Three Boundary Types

Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduction	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither created or destroyed)
Topography	Ridge/Rift	Trench	No major effect
Volcanic activity?	Yes	Yes	No



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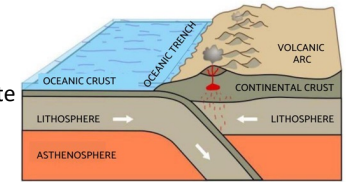
Divergent Boundaries

Divergent Boundaries occur when the Lithosphere (*upper crust*) moves under the Lithosphere of another tectonic plate creating an oceanic trench



Oceanic Trench

The oceanic trench is the zone under the divergent boundary where the oceanic crust. The lower lithosphere is absorbed by the upper mantle and creates fissures (*cracks*) in the crust. These fissures allow lava to flow up through the fissure and create volcanos.

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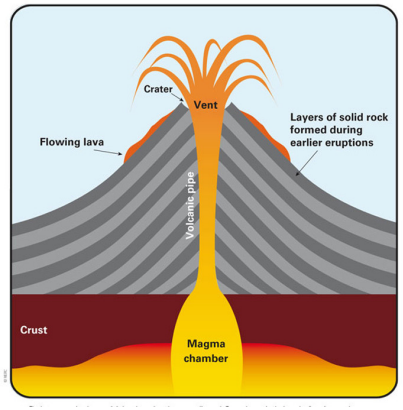
Volcanos

A *volcano* is a raised ridge (*mountain*) in the earth structure where *lava* (*liquid magma*) leaves the earth through a *vent* include a *crater*. The magma (*lava*) is held inside a magma chamber in the crust.

The released *lava* will quickly cool forming new *volcanic rock* on the surface of the mountain



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Types of Volcanos

Volcanos come in four main types

Cinder Cone Volcano

Standard volcano formed when lava leaves the earth through a vent inside a crater within the volcano

Stratovolcano Volcano

The mountain that results from *cinder cone volcano* repeated eruptions depositing rock outside the volcano leading to a mountain in it's place

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Types of Volcanos

Volcanos come in four main types

Shield Volcano

Volcano that is formed when multiple fissures along with a dome erupt leading to layers of lava forming in all directions.

Lava Dome

A *volcano* feature when magma is too thick to become lava and builds up into large mounds that clog the top of the volcano over time.

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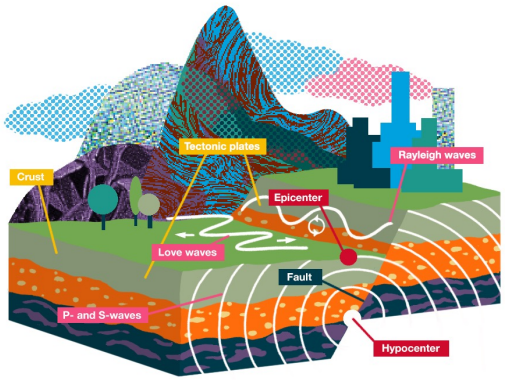
Earthquakes

An *earthquake* is a sudden movement of tectonic plates that causes energy in s and p waves to be transmitted through the crust. The Earthquake occurs at a *fault* between two *tectonic plates* at the *epicenter*.



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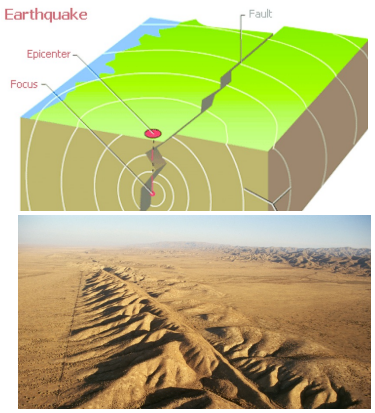
Earthquake Progress

The earthquake begins at the top of the earth crust at the *epicenter* above the *fault*.

In California, the two interacting *plates* are the Pacific and North American Plates, meeting at the *San Andreas Fault*, a fault 650 miles long and 10 miles deep. Additional smaller faults include the *Hayward* and *San Jacinto faults* which branch off the *San Andreas fault.*



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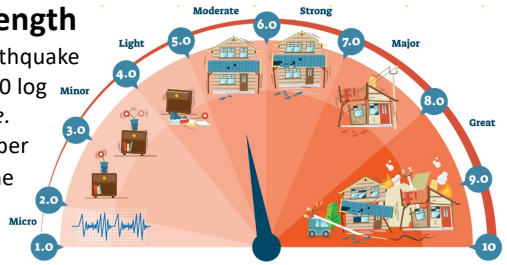
Earthquake Strength

The strength of an earthquake is based on the base 10 log scale, the *Richter Scale*. Each progressive number is 10x stronger than the last number on the Richter Scale



Notable Earthquakes

San Francisco (1906)	Baja California (2010)	Northridge (1994)
7.9	7.4	6.7

The San Fran Quake (7.9) was over 10x more powerful than Northridge (6.7)!

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