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## 1-Introduction

With a sudden shock the whole villages were wiped out, lives lost, people left homeless, no food left, no clean water, no help, no hope, this is the deadly reality of an earthquake. Now many may be left wondering how this all started, well, it all starts with the **tectonic plates**.

## 2-Tectonic Plates

One of the main fundamentals of earthquakes is the movement of **tectonic plates**. The movement of the plates are the building blocks of how earthquakes occur. Each year **tectonic plates** move approximately 2-5 centimetres and they move slowly over the globe. Due to the slow movement of **tectonic plates** earthquakes cannot occur all that often. **Tectonic plates** move because the **radioactivity**/heat from the earth's core pushes against the **tectonic plates** causing it to move, and as the gas cools down it moves back down into the earth's core (**Convection**). This is an incredibly slow process and can take years to make a major earthquake occur. The way that the **tectonic plates** move is determined on which way the gas rubs against the **tectonic plates**, this is also why some plates move towards each other and some plates move away from each other. When they move into each other this is called the **subduction zone** and this is where the **tectonic plates** collide. When they move apart this is called **divergent plate boundaries**.

When the **crust** goes under and over each other at the **subduction zones** (sometimes these collide causing an earthquake), the **crust** goes down into the **mantle** later melting into magma/lava becoming part of the **mantle**. Some of it goes into the magma chamber of a volcano, and as the **pressure** slowly builds up a volcanic eruption occurs. This can be seen looking at a map of volcanoes and **tectonic plates**, on the boundaries of the **tectonic plates** there are multiple volcanoes, this is also why the ring of fire exists. On a **subduction zone** this is where the plates go under and over each other, and where the rocks may be on a **fault**. It is also where the plates occasionally collide causing an earthquake, and is where most earthquakes occur. At **subduction zones** an **oceanic plate** slides under a **continental plate** or under another **oceanic plate**, (this is because **oceanic plates** are **denser** therefore floating lower on the **mantle** while the **continental plates** are less **dense** and they float higher on top of the **mantle**). This is where **geo hazards** (earthquakes & volcanoes) occur. The actual earthquakes are caused when rock that is underground breaks along a **fault**, and then the **seismic** energy and **seismic waves** make the ground shake. However, how this energy is released is when the 2 rocks and/or plates are rubbing against each other, the place that the rocks broke is rigid, so they won't slide smoothly against each other. So the rocks on either side will catch on to each other, but the rocks are still pushing against each other but the rocks are stopping the motion. So soon there will be too much **pressure** built up and the rocks will break, releasing **seismic waves**, causing an earthquake. The severity of an earthquake is caused by how much **pressure** is built up when the rocks stopped the plates rubbing against each other.

The positioning of the plates change a lot of things as well, because as stated earlier, where the tectonic plate boundaries are is basically prone to earthquakes and/or volcanoes. Volcanoes are just the **crust** that had melted after it had gone into the **mantle** when the **tectonic plates** were moving under and over each other and the **crust** had to go somewhere. At because at the **divergent plate boundaries** the gap spreads, which would leave a giant gap, well, the magma from the **mantle** rises up, because the **convection currents** push this up, So in reality the earth is just recycling rock that was melted into the **mantle**, over and over again. On **tectonic plates** there are also things called **collisional boundaries**, this is where 2 plates of the **continental lithosphere** collide. As they collide the rock is pushed upwards therefore creating mountains, this is apparently how the Himalayas and the Alps were formed. This would also create devastating earthquakes.

**Pangea** was a phenomenon that occurred 300 million years ago when all the land masses we know as countries and continents were formed together. Until 175 million years ago the **tectonic plates** began to move, therefore moving the continents/**continental plates** away from each other, hence the name, **Continental** drift. Because of the ways **tectonic plates** work, NASA estimates that in 250 million years from now, **Pangea** will form again and what they call **Pangea Ultima**. This would probably cause devastating earthquakes that would be unimaginable. Although our countries won't go underneath each other and engulf each other, because only **oceanic crust** goes under **continental crust**, **continental crust** doesn't go under **continental crust**. Instead the continent will clash, causing earthquakes; these would be **collisional boundaries** and will cause a lot of mountains to form.

### 3-Seismic Waves

But there are also something called **seismic waves**. When an earthquake occurs there are 2 types of **seismic waves**; **surface waves** and **body waves**. **Body waves** are **seismic waves** that travel through solids & liquids, so they travel through the earth, the rock and the **mantle**.

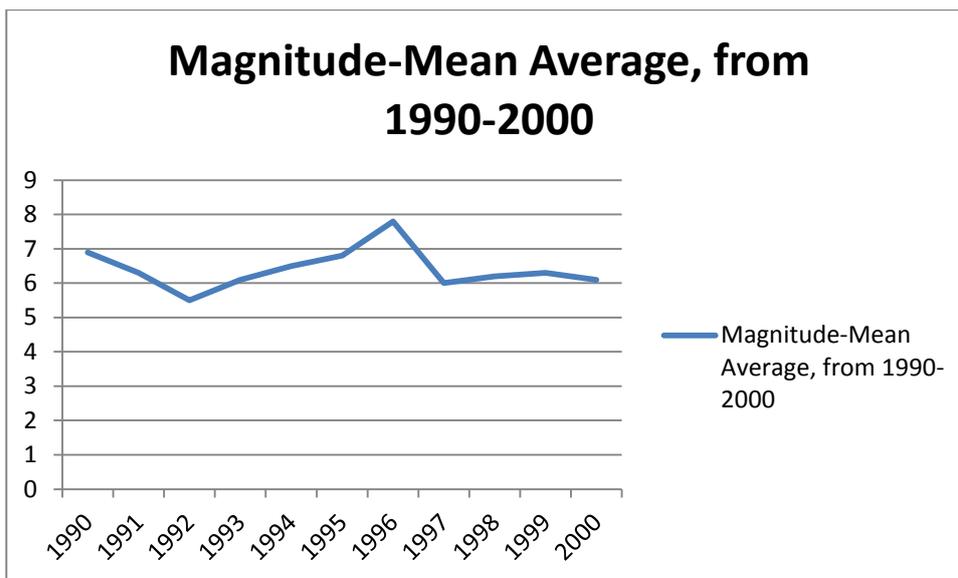
**Body waves** are faster than **surface waves** and are of higher **frequency**. But there are specific types of **body waves**; there are P waves and S waves. P waves, also known as the primary wave, these are the fastest type of **seismic wave**, and they are the first to arrive at the **seismic station**. P waves push and pull rock, although these are not that deadly because people normally only felt the rattle of the wave. P waves are also called compressional waves because of the way that they act, the **particles** move in the same direction that the wave moves, or the same direction the energy is moving, this is called the **direction of propagation**, here is a link to show a better understanding;

[http://www.geo.mtu.edu/UPSeis/images/P-wave\\_animation.gif](http://www.geo.mtu.edu/UPSeis/images/P-wave_animation.gif)

But P waves are not the only type of **body wave**; there are also S waves, also known as; Secondary Waves. S waves are the second waves that arrive at a **seismic station**, therefore making it slower than the P wave and faster than both **surface waves**. But what makes it special is that the S wave cannot move through liquid, it can only move through a solid, S waves move the rock **particles** up and down and side to side, perpendicular to the direction the wave is travelling in, (The direction of wave propagation), here is yet another link to explain how S waves work; [http://www.geo.mtu.edu/UPSeis/images/S-wave\\_animation.gif](http://www.geo.mtu.edu/UPSeis/images/S-wave_animation.gif) During the description of S waves It was confirmed that S waves can only go through solids and not liquids, so this is what led **seismologists** to believe that the earth's **outer core** is actually a liquid.

But there are also things called **surface Waves**, these waves don't go through the inner layers of the earth, instead they travel along the surface of the earth. Unlike **Body waves**, **surface waves** only travel through the **crust** and have a lower **frequency** than **body waves**. These arrive after the **body waves**, and are mainly responsible for the destruction caused by an earthquake. The first type of **surface wave** is the Love wave, this is the fastest type of **surface wave** and moves the **particles** entirely from side to side, and this wave was named after A.E.H Love who found the mathematical model for this wave in 1911. This is how the love wave works; [http://www.geo.mtu.edu/UPSeis/images/Love\\_animation.gif](http://www.geo.mtu.edu/UPSeis/images/Love_animation.gif) then there is the Rayleigh wave. A Rayleigh wave rolls along the ground like a wave rolls along the ocean, this moves up and down, side to side in the direction that it is moving, Rayleigh waves are one of the biggest waves, and causes most of the shaking, here is a diagram to show how it works; [http://www.geo.mtu.edu/UPSeis/images/Rayleigh\\_animation.gif](http://www.geo.mtu.edu/UPSeis/images/Rayleigh_animation.gif)

#### 4-Graph on **Magnitudes**

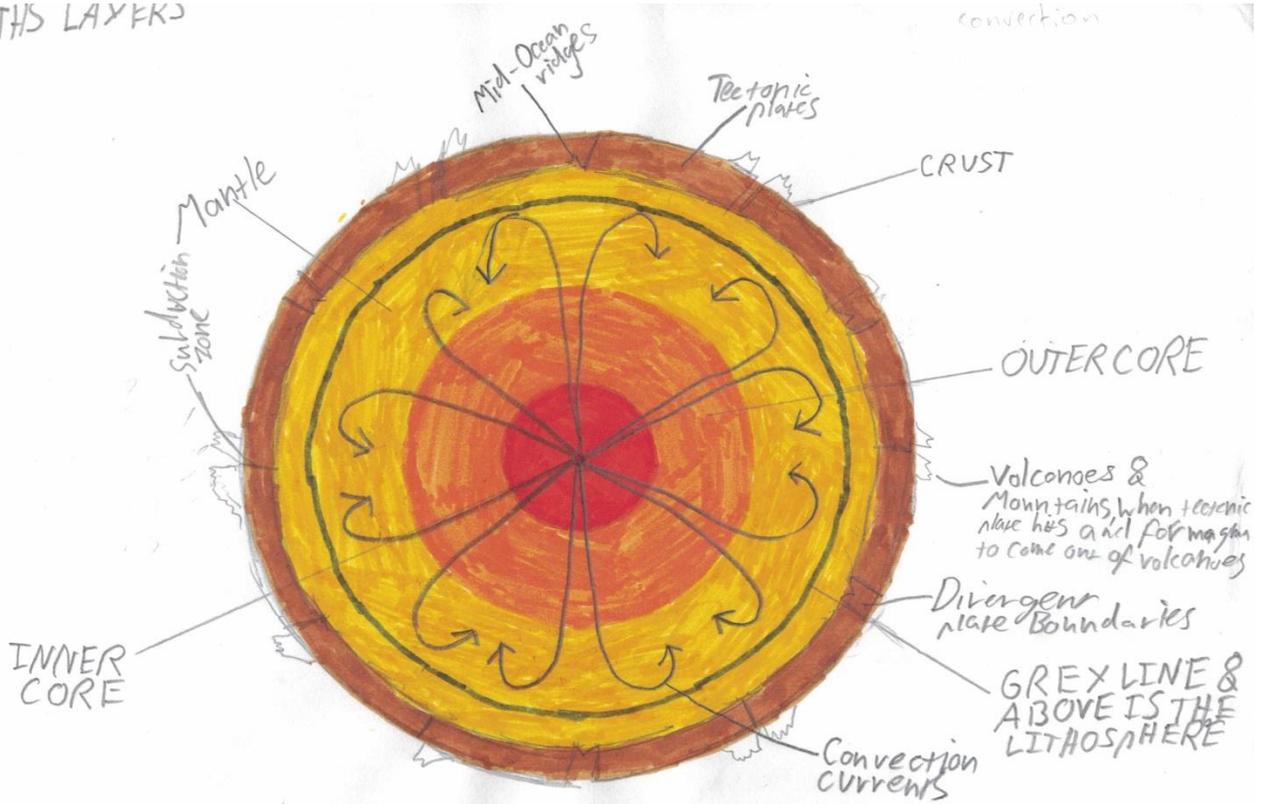


Here is a graph of the mean average of the **magnitudes** of DEADLY earthquakes from 1990-2000, the question posing was; have the **magnitude** of earthquakes gone higher over the years? The graph looks like it's in a completely random order, because it is. It is up to chance if the **magnitude** of earthquakes will be increasingly higher or lower each year, and it will always be that way. Because the **tectonic plates** always move about the same each year, and earthquakes have developed a system that will most probably never stop, so the **magnitudes** of earthquakes is just chance. Most likely earthquakes will just have random **magnitudes**.

## 5-Diagram of Earth's Core

This diagram shows the layers of the earth and many other minor details regarding the topic that this information text is about. First of all there is the **inner core**; this is made of iron and a few other elements. Its heat ranges from 5000-7000 degrees Celsius, (the iron has not melted due to the sheer **pressure** of the weight on it). Then there is the **outer core**, this is a liquid layer of the earth's core. And the heat is ranging from 4000-5000 degrees Celsius. While the **mantle** is made up of magma (semi-molten rock) and its heat is from 500-900 degrees Celsius. Finally there is the **crust**, this is where the **tectonic plates** lie and where all the magic, that is earthquakes happen. There is a dark grey line that is the **lithosphere**; the **lithosphere** is the uppermost part of the **mantle** and all of the **crust**. And the **lithosphere** is made up of **tectonic plates**, so the **lithosphere** IS the **tectonic plates** except it represents the **tectonic plates** as a whole. There are also those arrows, these are called **Convection currents**. **Convection** is how heat is transferred by mass motion of air and water (**fluids**) when a heated **fluid** is forced to move away from the source of heat carrying energy (the heat) with it. **Convection** above a hot surface occurs because when the air is heated it expands and becomes less **dense**, therefore it rises, and a **convection current** is simply when a **current** in a **fluid** that is caused by **convection**, much like how a **current** in water works. So **convection currents** come from the earth's core, because of the heat making the **fluid** less **dense**, causing it to rise with the energy (heat) then when it reaches the **mid-ocean ridges/tectonic plates** the energy (heat) is lost. Causing the **fluid** to cool down, which makes the **fluid denser** therefore making it float back to the earth's core. There are also **mid-ocean ridges**; this is where an underwater mountain range is created by **tectonic plates**. This is caused when the **convection currents** rise under the **oceanic crust**, and that created magma where 2 **tectonic plates** meet at a **divergent plate boundary**.

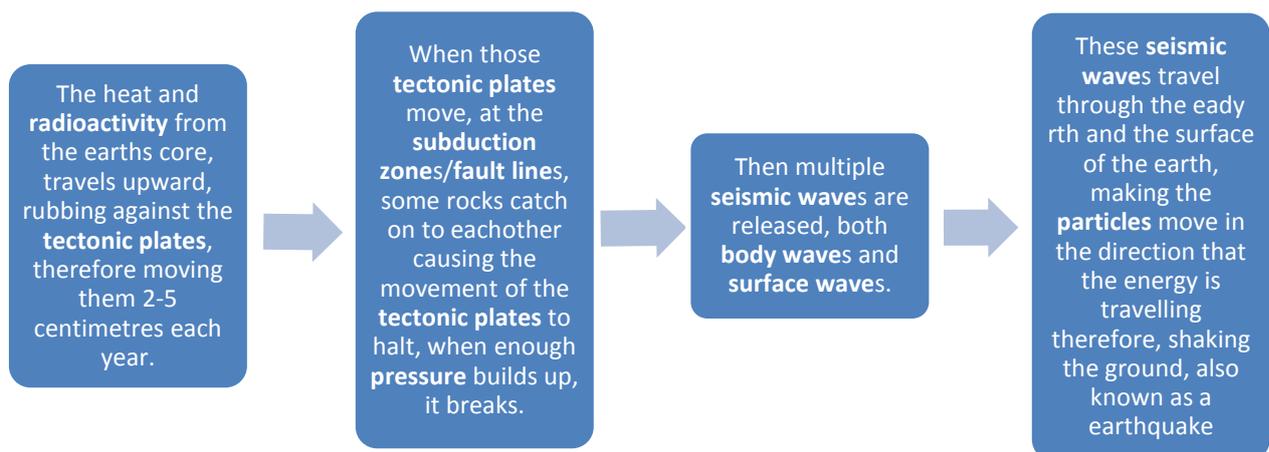
# EARTH'S LAYERS



## 6-System Analysis

### System Analysis:

If there wasn't any radiation coming from the earth's core, the **tectonic plates** wouldn't move, so at the **subduction zones** nothing would happen and no **seismic waves** would've been released, therefore there would be no such thing as an earthquake. Now if there is no such thing as **subduction zones/fault lines**, so that would probably mean that the continents will just move in a circle around the sphere that is earth, endlessly, which wouldn't change that much, and there will also be no such thing as earthquakes. But if no rocks got stuck on each other, firstly the earth will have to be completely spherical and there would be no mountains, the earth will have to be COMPLETELY spherical so the rocks couldn't catch onto each other and would just run smoothly into the **mantle**, and once again there would be no such thing as earthquakes. BUT what if the rocks that caught onto each other didn't break, like an immovable object? Well, the whole entire movement of **tectonic plates** will probably halt, and the earth's continents wouldn't move, therefore leading to no earthquakes, but what if the movement of **tectonic plates** was an unstoppable force?, wouldn't the earth's **tectonic plates** be able to break it, right? If there were no **seismic waves**?, Well quite simply if no **seismic waves** were released the earth wouldn't shake, so there would be no earthquakes, BUT what if there was no such thing as **body waves**. Well as stated before **body waves** only cause minor damage and **surface waves** cause the most damage so most of the damage will still happen, but if there was no such thing as **surface waves** most of the damage will still happen, and finally if the **seismic waves** didn't move any **particles** at all, there would be no such thing as earthquakes, and **seismic waves** probably wouldn't be noticeable and we would never know of their existence.



## Glossary

**Tectonic Plates**-**Tectonic plates** make up what's known as the **lithosphere**, (**crust** & upper **mantle**) there are 8 major **tectonic plates**, the **convection** from the earth's core moves these plates 2-5 centimetres a year.

**Subduction zone**-A **subduction zone** is where the **tectonic plates** meet, when the **tectonic plates** move, they have to go somewhere, so they meet at **subduction zones**. The **tectonic plates** go underneath each other soon melting into the **mantle**.

**Divergent plate boundaries**-This is where the **tectonic plates** are moving away from each other, because at the **subduction zones** they move towards each other, when this happens the **convection currents** push the **mantle** up taking the place of the **crust** that had gone into the **mantle** at **subduction zones**.

**Fault/Fault line**-A **fault** is a break in the earth's **crust**, what defines a **fault** is the movement of the rocks on either side, when this movement is sudden an earthquake occurs.

**Collisional boundaries**-**Collisional boundaries** also known as continent collision is when at **convergent boundaries** the **subduction zone** gets destroyed mountains are created and 2 countries are stuck together.

**Convergent boundary**-A **convergent boundary** is when 2 or more **tectonic plates** (or parts of the **lithosphere**) move towards each other and collide.

**Mid-ocean ridges**-A **mid ocean ridge** is a underwater mountain range, this is created when **convection currents** make the **mantle** rise where 2 **tectonic plates** meet at a **divergent plate boundary**

**Lithosphere**-The **lithosphere** is the rigid and hard outside consisting of the upper **mantle** and the **crust**, the **lithosphere** is made up of **tectonic plates**.

**Crust** -The **crust** is made up of **igneous** and many other types of rocks. And this is uppermost part of the earth.

**Igneous rocks**-**Igneous rocks** are just solidified magma and lava.

**Mantle**-The **mantle** is in between the **crust** and the **outer core** (as shown on diagram) and is a silicate rocky shell, this makes up 84% of the earth's volume.

**Outer core**- the **inner core** is the **fluid** layer of the earth, and is mostly composed of iron and nickel.

**Inner core**- this is the innermost part of the earth and is primarily a solid iron ball.

**Continental crust**-The **continental crust** is the **crust** that we know as countries, it is older than **oceanic crust** and the reason that it is elevated higher than **oceanic crust** is because it is less **dense**, causing it to float higher on the **mantle**.

**Oceanic crust**-**Oceanic crust** is the **crust** that is **denser** so it's elevated lower on the **mantle**, these also hold **mid-ocean ridges**.

**Dense**-A closely compacted substance or a substance that **particles** are closely compacted.

**Geo Hazards**-Also known as **geological hazards** are **hazards** such as volcanoes and earthquakes.

**Convection**-**Convection** is heat transfer by mass motion, when a heated **fluid** is forced to move away from source of heat, carrying the energy/heat with it. When **convection** occurs above a hot surface, the air expands causing it to become less **dense** and rise, but when it loses the energy/heat it goes back to normal and sinks back down.

**Convection current**-a **convection** is a **current** that is formed by the process of **convection**.

**Fluid**-A **fluid** is practically a gas or most commonly a **fluid**.

**Radioactivity**-Also known as **radioactive** decay, this is when an unstable atom loses energy emitting radiation. Every material does this, except **radioactive** materials do it much quicker.

**Pangea/Pangea ultima**-**Pangea** was a super continent that consisted of all the countries and continents that we know today, it was assembled 300 million years ago and began to drift 175 million years ago. Although **Pangea ultima** is what NASA is suggesting will occur in 250 million years, this is when all the continents will form back together.

**Seismic Waves**-A **wave** in the earth that is caused by earthquakes, this is much like sound waves and how they work. These are also described as waves of energy that travel through and on top of the earth's layers. **Surface waves** consist of Love waves and Rayleigh waves.

**Surface waves**-**Surface waves** are a type of **seismic wave** that travels along the top of the earth's **crust**, these have longer wavelengths and they travel slower than **body waves**.

**Body waves**-A **body wave** is a type of **seismic wave** that travels through the earth's layers, these have shorter wavelengths and are faster than **surface waves**. **Body waves** consist of P waves and S waves.

**Seismic station**-A **seismic station** is a laboratory that has the equipment to detect, monitor and record earthquakes locally and/or anywhere in the world.

**Frequency**-**frequency** is how much a repeated circuit happens in one second, this can be shown by wavelengths, this has a different meaning with sound and other science areas.

**Direction of propagation**-In geology, **direction of propagation** is the way the **seismic waves** move or the way the energy moves, the way the energy moves is also the way the **particles** move.

**Particles**- A particle is a minute fragment or quantity of matter.

**Pressure**-A continuous physical force exerted on an object and/or something in contact with it.

**Seismologists**-**Seismologists** are a certain type of scientist that studies earthquakes and other **geological hazards**; they also use tools and equipment to monitor the earth's **crust**.

**Magnitude**-A **magnitude** is a number that characterizes an earthquake and how big it is.

**Magnitude** is based on the maximum motion given to a seismograph and is measured on the Richter scale.

8-conclusion

Earthquakes will always be around and will always devastate our daily lives, this is an ongoing thing and will never stop until the world either ends or we can make it stop.

## 9a-Bibliography

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