# WJEC (Wales) Physics GCSE

## 1.7: Seismic Waves

### Detailed Notes

(Content in **bold** is for higher tier **only**)

## Seismic Waves

**Earthquakes** produce seismic waves as they cause the ground to **vibrate**. There are three main types of seismic waves:

### P-Waves

P-waves are **longitudinal** and can travel through **solids and liquids**. They travel **faster** than the other seismic wave types.

### S-Waves

S-waves are **transverse** and can only travel through **solids**. They are **slower** than p-waves.

### Surface Waves

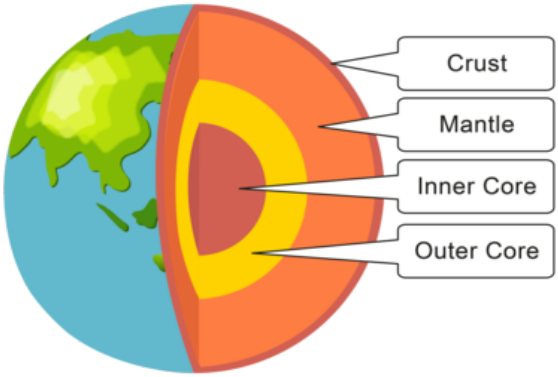
Surface waves are **longitudinal**. They are the **slowest** type of seismic wave and only travel across Earth's surface. They **do not penetrate** into the ground.

## Structure of Earth

The internal structure of the Earth consists of several **different layers**, each with **different properties**. These have been hypothesised from analysing seismic waves and signals that have travelled through the Earth.

The surface layers are the crust and upper mantle (lithosphere) which is broken up into large fragments called tectonic plates. When these plates move, friction between them causes a release of energy and stress that produces seismic waves (earthquakes).

The mantle sits below the crust and is more fluid. It still has the properties of rock (i.e. is solid) but can slowly flow, enabling the movement of the tectonic plates.



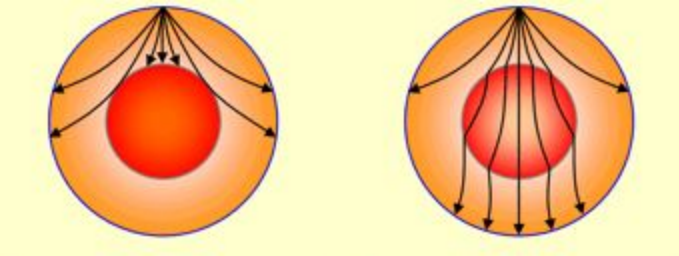

***Internal Structure of the Earth (goconqr.com).***

The Earth's core is made up of an inner and outer core. The outer core is a liquid, made up of molten iron and nickel. The inner core comprises solid iron and nickel. Earth's core is very large and its diameter is over half that of the whole Earth.

### Seismic Wave Paths

P and S-waves can be used to determine Earth's **internal structure**. The speed of seismic waves increases with depth explaining why they travel with **curved paths** within the Earth. At each layer boundary, the waves can be refracted as the density of each layer changes (generally increasing with depth).

S-waves can only travel through solids, meaning they cannot pass through the molten outer core. Therefore, only p-waves can be detected on the opposite side of Earth to a quake. This creates an s-wave **shadow zone** where s-waves cannot be detected after an earthquake. Typically this zone sits between 105º angles from the quake epicentre. This observation provides evidence for the existence of a **solid mantle** and a **liquid outer core**.



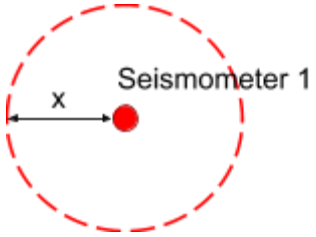
**S-Waves** **P-Waves**

***Seismic wave paths within Earth (sutori.com).***

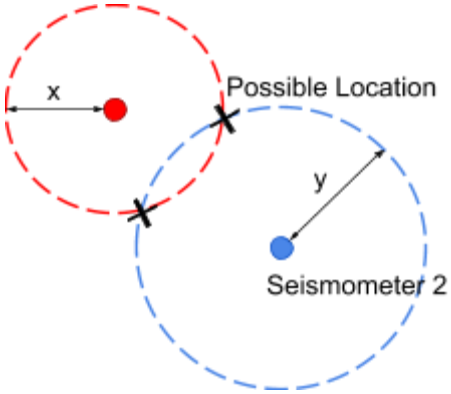
## Locating Earthquake Epicenters

An epicentre is the point at which an earthquake originates from. It can be determined by looking at the seismic record. This record will give the time lag between the arrival of p-waves and s-waves which can be used to calculate the distance of the recording station from the epicentre. However this method cannot determine the direction, so loci circles around multiple stations have to be used to narrow down the epicentre location.

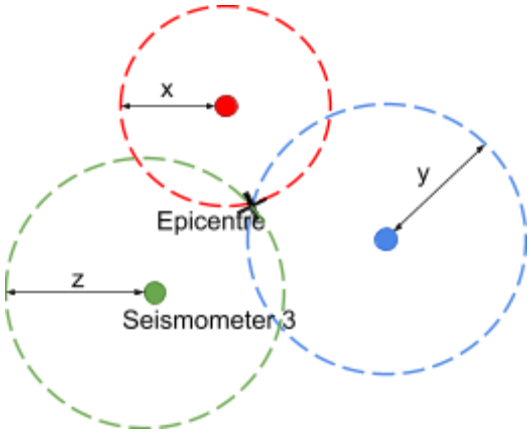
**Example:**




**The quake occurs at a distance x from the seismometer but the direction is unknown.**




**With data from a second seismometer there are two possible locations of the epicentre, where the two circles intersect.**




**A third seismometer allows a single location to be pinpointed for the epicentre.**