

## 1.0 Earth's surface undergoes gradual and sudden changes

### 1.1 A Model for Earth

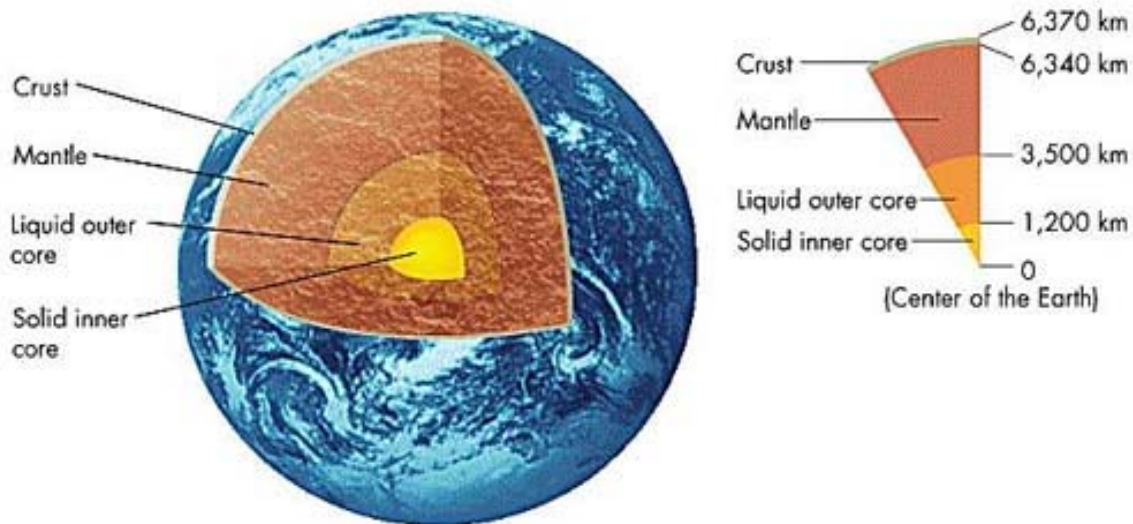
The story below the surface of the Earth is a mystery. The motion picture – **The Core** – tries to explain this mystery in a way that we can visualize it and understand it. Scientists make educated guesses based on data they collect from events that shape and reshape our planet every day. They try to understand this evidence so that they can explain how our planet began and what it is made of.

#### *Developing A Model*

A model is an idea of something that cannot be fully known or seen. It is a way of demonstrating an understanding based on evidence that is collected and interpreted, based on current knowledge. Models can take many forms: drawings, constructions, and comparisons to similar things.

#### *What's Inside Earth*

Geologists use a model to help them understand the inner structure of the Earth. This model is based on *indirect evidence*. The **crust** is the top layer of the Earth. Below it is the **mantle**, which is made of rock material (upper part is solid, lower part is partly melted). The upper mantle and crust are called the **lithosphere**. Below the mantle is the **core**. The **outer core** is made up of mainly liquid iron and nickel, while the **inner core** is solid.



#### *The Crust*

The crust is the layer of the Earth that we live on – the surface. It contains many minerals and fossil fuels, which help to supply much of our need for energy. It is also the thinnest part of the Earth. Because the inner part of the Earth is so hot, the crust radiates heat into the atmosphere. Despite the very thin film of soil and vegetation, the crust is primarily made of rock.

## 1.2 Sudden Earth Events

Few forces in nature are as devastating and Earth shattering as Earthquakes and Volcanoes. These are examples of sudden changes, that can transform a peaceful neighborhood into a shattered wasteland in a matter of minutes. **Kobe, Japan** – Earthquake killed 5000 people. **Mt. St. Helens** – Volcano killed 57 people and destroyed 560 square kilometers of land. Most recently, an undersea earthquake - in the Indian Ocean, caused the **Tsunami** which killed 150,000 or more people.

### *What Causes Earthquakes?*

Earthquakes occur when tectonic plates break or move suddenly

#### *Types of Rock Movement in Earthquakes*

- where the plates meet, the rock is under great pressure, which can make it bend and stretch - when the pressure is too great, the rock breaks suddenly creating a **fault**
- there are three types of movement, of the tectonic plates, along a fault
- **Normal Faults**, (pulling action, which breaks rocks apart) - North Atlantic
- **Reverse Faults** (compression, where rocks are squeezed, causing them to bend and break) - Marianas Trench, near Japan
- **Strike-Slip or Transform Faults** (shear causes slipping, which makes the jagged edges break off) - Pacific Plate

### *The First Break*

The **source** of an earthquake deep in the crust is called the **focus**, where the sudden breaking of the rock releases energy that spreads as waves through the Earth. These waves are called **seismic waves**.

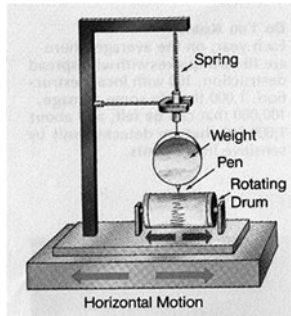
The **p waves** (primary waves) and **s waves** (secondary waves) originate at the focus.

it is possible to determine the location of an earthquake by the interval between the p waves and the s waves (the farther apart they are, the further away the earthquake is

- the surface waves come from the **epicentre** (the location on the surface directly above the focus)

### *Measuring The Strength Of Earthquakes*

Scientists called **seismologists** use a **seismograph** to record the intensity of an earthquake.



- the seismograph must be attached to **bedrock** (the solid rock that lies beneath the soil and looser rocks) to feel the vibrations on the plate
- a marking pen, inside the seismograph, records the vibrations on a rotating drum (modern seismographs are electronic)
- the measurement scale used is called the **Richter scale**

### *An Ancient Chinese Device to detect Earthquakes*

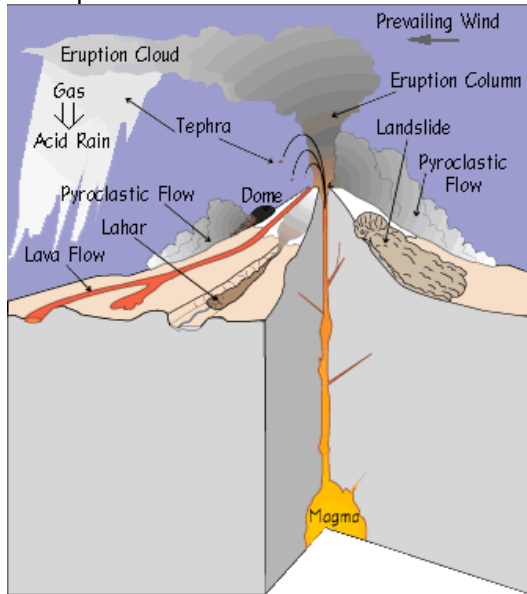
Invented around 132 A.D., it consisted of a wine jar with eight dragon's head spouts which pointed in the compass rose directions.. A ceramic frog sat below each spout, which had a ball. With its open mouth, each frog was ready to catch any ball dislodged by an earthquake. The direction of the earthquake could be determined by which frogs caught balls.



<http://volcano.und.nodak.edu/volcanoes.html> (*Volcano World*)

**Volcanoes**

A **volcano** is an opening in the Earth's crust that releases lava, steam and ash when it **erupts** (becomes active). The openings are called **vents**. When volcanoes are not active, they are called **dormant**. Scientists are better equipped to predict volcano eruptions than they are at predicting earthquakes.



**Famous Volcanoes**

- the eruption of **Mt. Etna** in Italy this past summer shows that volcanoes cannot be predicted and don't always behave in ways scientists think they will behave. They can be rather spectacular (as the video link shows).
- the most active volcano on the Earth is **Kilauea** in Hawaii (**Loihi** is a new volcano forming beside the main island in Hawaii - creating a new island)
- **Krakatau**, in Indonesia (blast was heard 4800km away and tsunamis waves were 30 m high)
- **Mount St. Helens**, in Washington (sideways and vertical eruptions)
- **Mount Vesuvius**, in southern Italy (**City of Pompeii** was buried - it is due for another large eruption because it is sealed with a 'rock plug' that could blast 1.5 km upwards)
- **Mount Pinatubo**, in the Philippines (ash circled the globe and cooled temperatures around the world)

- Volcanoes on **Io**, one of **Jupiter's moons** have been photographed using Vidicon - a type of TV camera mounted on the Voyager spacecraft, using an electron gun and photoconductor
- those on **Mars** and our **moon** have been extinct for millions of years, while those on **Venus** may still be erupting
- the largest volcano found in our universe is the extinct **Olympus Mons** on Mars

**Current Volcano update:** [http://volcano.und.nodak.edu/vwdocs/current\\_volcs/current.html](http://volcano.und.nodak.edu/vwdocs/current_volcs/current.html)

- volcanoes that form a circle around the Pacific Ocean are called the **Ring of Fire** (derived from the circle of volcanoes that pour out red hot lava, fire and steam)

**Tools and Techniques For Studying Earth**

Volcanologists, Geologists and Seismologists take risks whenever they explore the world of Earthquakes and Volcanoes. Their efforts to learn more about these sudden Earth events may one day enable us to predict with more accuracy when they will occur.

**Tools of the Trade**

Silver Fire Suit



Reflects extreme temperatures

Surveyor's level



Detects changes in the slope of the ground

Seismogram

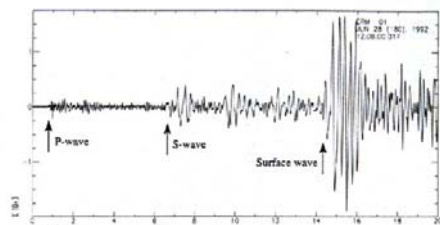


FIGURE 6.4 A seismogram.

Determines the strength and location of an earthquake

### 1.3 Incremental Changes: Wind, Water and Ice

Weathering (3 types) breaks down and wears away rock, creating sediment. Erosion is the movement of rock and mineral grains from one place to another. Deposition is the process of placing the materials that are carried by water, wind and ice.

#### *Mechanical Weathering*

- the physical break-up or disintegration of rocks, caused by gravity, temperature change and frost wedging
- mechanical weathering 'wears away'
- sedimentation 'builds-up'

#### *Chemical Weathering*

- chemicals, present in the earth's surface or atmosphere, can be dissolved in water and react in the chemical decomposition of rocks and minerals (acid rain)

#### *Biological Weathering*

- living organisms (plants, animals, bacteria and fungi ) can breakdown rock
- plant roots, acidic fluids produced by roots, bacteria, fungi and some insects and small animals can cause chemical reactions

#### *The Effects of Moving Water*

Water is one of the most powerful causes of erosion. Sudden or incremental changes occur due to the movement of water - rivers, rain, ocean waves. As rivers flow they carry a load of silt, sand, mud and gravel, called **sediment**.

When a river becomes mature it begins to meander (curving its bed from side to side). As it slows the sediment begins to fall to the bottom. **Sedimentation** is the process of sediments being deposited, usually at the bottom of oceans, lakes and rivers.

Landforms created by flowing water are called **fluvial landforms**.

The powerful forces of erosion caused by moving water wear away rock and soil and transport them to other locations.



#### *Eroding Away*

Agents of erosion include: glaciers, gravity, wind, and water. Changes can occur **gradually** (glaciers) or **suddenly** (flash floods, landslides, rock slides). **Gravity** causes landslides and rock slides – eg. Frank Slide (a **retaining wall** can often be used to hold back unstable material – but this is not always the best protection). **Wind** carries rock particles across the landscape, eroding the land by **abrasion** (planting vegetation, contour farming and reduced tillage can reduce the effects of wind erosion).

#### *Glaciers – Rivers of Ice*

Large rocks caught up in a glacier and then left behind when the glacier recedes are called **erratics**. Sediment that is pushed away, as the glacier moves forward, are called **moraines**. Scratches, made in the bedrock, by glaciers carrying rocks are called **striations**. As the glacier melts (or, retreats) it leaves behind sediment in the form of small hills, called **drumlins** and snake-like hills called **eskers**.