Earthquakes

An introduction to earthquake monitoring techniques

TEACHER'S COPY

Aims

- To understand what an earthquake is and where they occur
- To gain an insight into how earthquakes are recorded and how to interpret the data
- To introduce three of the seismic waves, P-waves, S-waves and Rayleigh waves
- To understand the importance of building an earthquake proof building

Gathering Techniques

- Observation
- Extracting information
- Asking questions

Processing Techniques

- Annotation
- Calculations

Glossary

Earthquake – a sudden release of energy that results in seismic waves

Aftershock – a small earthquake that occurs after a larger earthquake

Seismometer– an instrument that measures the motion of the ground

Seismic network – a number of seismometers in different locations that together measure where an earthquake occured and its strength (magnitude)

Body wave – a wave that travels through the Earth's interior (e.g. P waves, S waves)

Surface wave – a wave that travels on the Earth's surface (e.g. Rayleigh waves)

Plate Boundary – the edges of adjacent lithospheric plates where earthquakes are more frequent - the three types of boundaries are convergent, divergent and conservative

Tsunami – a series of abnormally large water waves caused by the displacement of a volume of water in the ocean (usually caused by earthquakes)

Mercalli Scale – a seismic scale used to measure the intensity of earthquakes

Seismic Waves

Seismic waves are **VIBRATIONS** generated by displacement or movement of the Earth's tectonic plates. Waves travel through the Earth and although they can be small, they can still be detected at great distances by an instrument called a **SEISMOMETER**

Seismometers around the world continuously monitor the different types of seismic events caused by tectonic activity.

By using a network of seismometers around the world, the **LOCATION** of the source of each event can be determined by comparing **P-WAVE AND S-WAVE ARRIVAL TIME** at each seismometer.

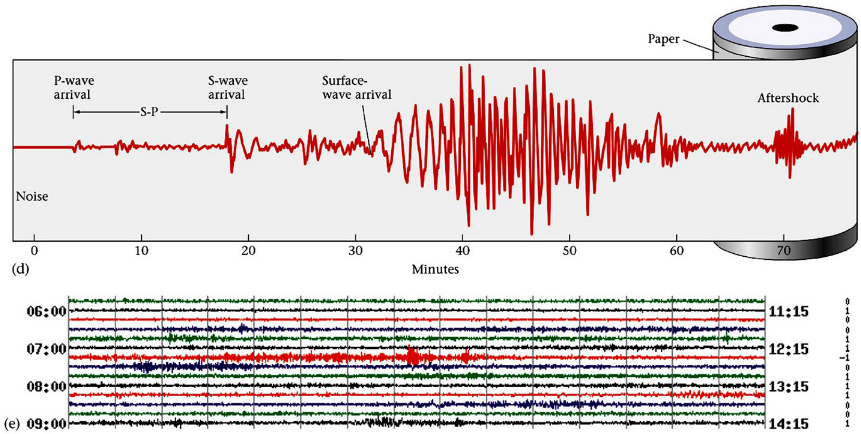
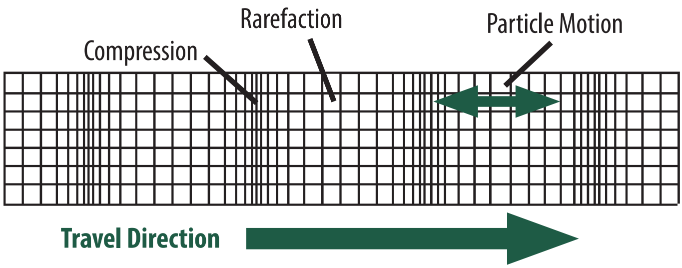


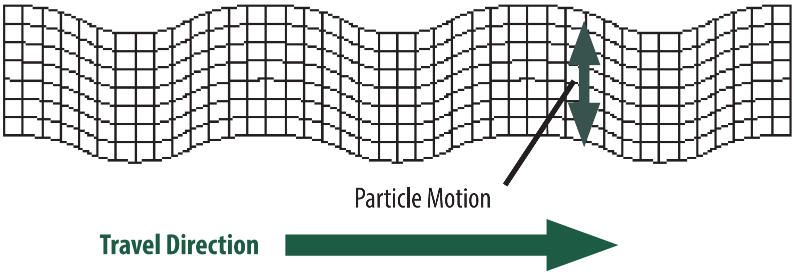
FIGURE 10.14

Earth: Portrait of a Planet, 2nd Edition



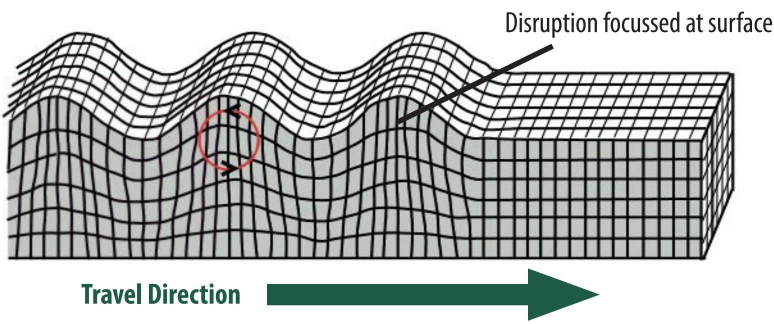
Name the wave type above **P-WAVE (COMPRESSION)**

Is this a BODY wave or a SURFACE wave? **BODY**



Name the wave type above **S-WAVE (SHEAR)**

Is this a BODY wave or a SURFACE wave? **BODY**



Name the wave type above **RAYLEIGH WAVE**

Is this a BODY wave or a SURFACE wave? **SURFACE**

Building in an Earthquake Zone

Based on what you have learnt about earthquakes and constructing buildings that can withstand ground motion, draw and label a diagram of the support beams in your building.

How tall was your building?

IF NOT MEASURED, ENCOURAGE PUPILS TO ESTIMATE (E.G. 2 STORIES)

How did your building design stand up to the earthquake? What made it strong and what made it weak?

EXAMPLES MIGHT INCLUDE ...

STRONG: TRIANGLES, LOW CENTRE OF GRAVITY, SOLID JOINTS, REINFORCEMENT

WEAK: OPEN SQUARES/RECTANGLES, POORLY CEMENTED JOINTS, NARROW BASE

What changes would you make to the design to make it more stable when shaken?

ADD TRIANGLES, WIDE BASE, STRONG JOINTS, NO LOOSE BEAMS ETC.

Sketch these changes in the space below.

Why did you make these changes?

INCREASE STRENGTH, LOWER CENTRE OF GRAVITY

Have the changes improved the structure of your building?

Building Examples

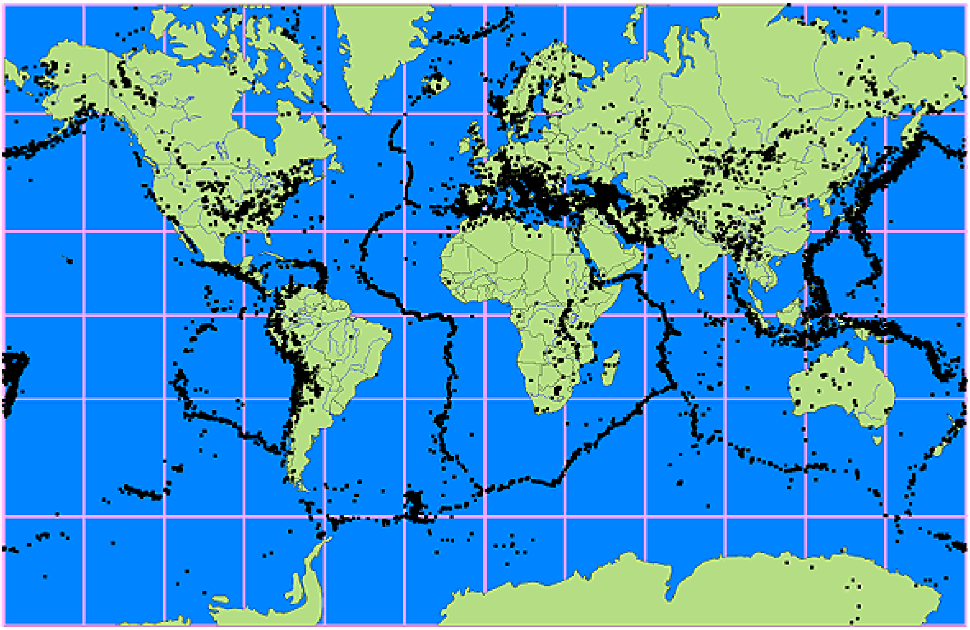
Transamerica Pyramid

San Francisco

Torre Mayor

Mexico City

Earthquakes worldwide



This map shows the distribution of earthquakes on Earth. What pattern do they follow?

THE OUTLINE OF THE TECTONIC PLATES

Many people live in earthquake-prone zones. What makes earthquakes so dangerous?

SHAKING CAUSES DAMAGE TO BUILDINGS AND INFRASTRUCTURE WHICH CAN

COLLAPSE AND INJURE OR TRAP PEOPLE

Did you know?

? The earliest recorded evidence of an earthquake is thought to be from 1831 BC, in the Shandong province of China

? The largest recorded earthquake in the world was a magnitude 9.5 recorded in Chile on May 22, 1960

? It is estimated that there are 500,000 detectable earthquakes in the world each year - 100,000 of those can be felt, and 100 of them cause damage

? Between 200 - 300 earthquakes every year are detected and located in the UK by the British Geological Survey

? Most earthquakes occur at depths of less than 80 km (50 miles) from the Earth's surface

? Moonquakes ("earthquakes" on the moon) occur, but they happen less frequently and have smaller magnitudes than earthquakes on the Earth

? The deadliest earthquake occurred in 1556 in China, striking a region where most people lived in caves carved from soft rock and killing an estimated 830,000 people

For more earthquake facts, check out USGS: Earthquake Facts.

You can also find a visulisation of the most recent earthquakes from across the world on the BGS Earthquakes page, and your school can get involved in the UK School Seismology Project.

Mercalli Scale

How an earthquake feels

The Modified Mercalli (MM) scale is a means of categorising the effects of shaking on people, structures and the environment.

MM5

Generally felt outside.
Small unstable objects displaced.
Some windows and pipes crack.

MM6

Felt by everybody.
Difficulty experienced in walking.
Objects from shelves tend to fall.
Slight damage to poorly constructed buildings.

MM7

Difficulty standing.
Noticed by drivers of cars.
Furniture movement.
Tiles, water tanks, walls & some buildings damaged.

MM8

Steering of cars affected.
Buildings damaged (may include some damage to earthquake resistant buildings).
Cracks in ground.

MM9

Heavy damage to buildings, bridges and roads.
Larger cracks in ground.
Landslides on steep slopes.
Liquefaction effects intensify.

MM10

More intense damage, including serious damage even to earthquake resistant buildings and bridges.
Most unreinforced masonry structures destroyed.

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