



SCIENCE JOURNAL • MODULE 2

Planet Earth, Water, Weather, and Space



Grades 4–6

MODULE 2 • WEEK 1

Rocks: From the Centre of the Earth to the Soil



Class 1 Inside the Earth, and Igneous Rocks

Class 2 Rocks from Pieces, Rocks Transformed — and Crystals

Class 3 Soil: Rock's Final Chapter



MODULE 2 · WEEK 1 · CLASS 1

Inside the Earth, and Igneous Rocks

The layers of our planet, and the rocks that form from melted stone

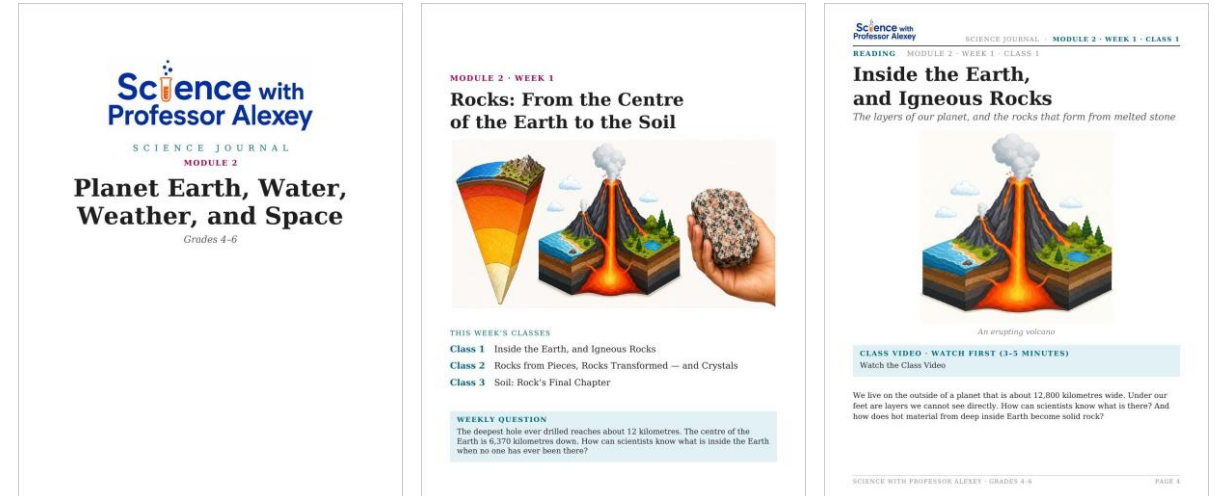
The Science Journal

Every class has a **Science Journal PDF** that contains:

- Reading
- Figures
- Problems to try
- Experiments to do
- Journal entries to complete

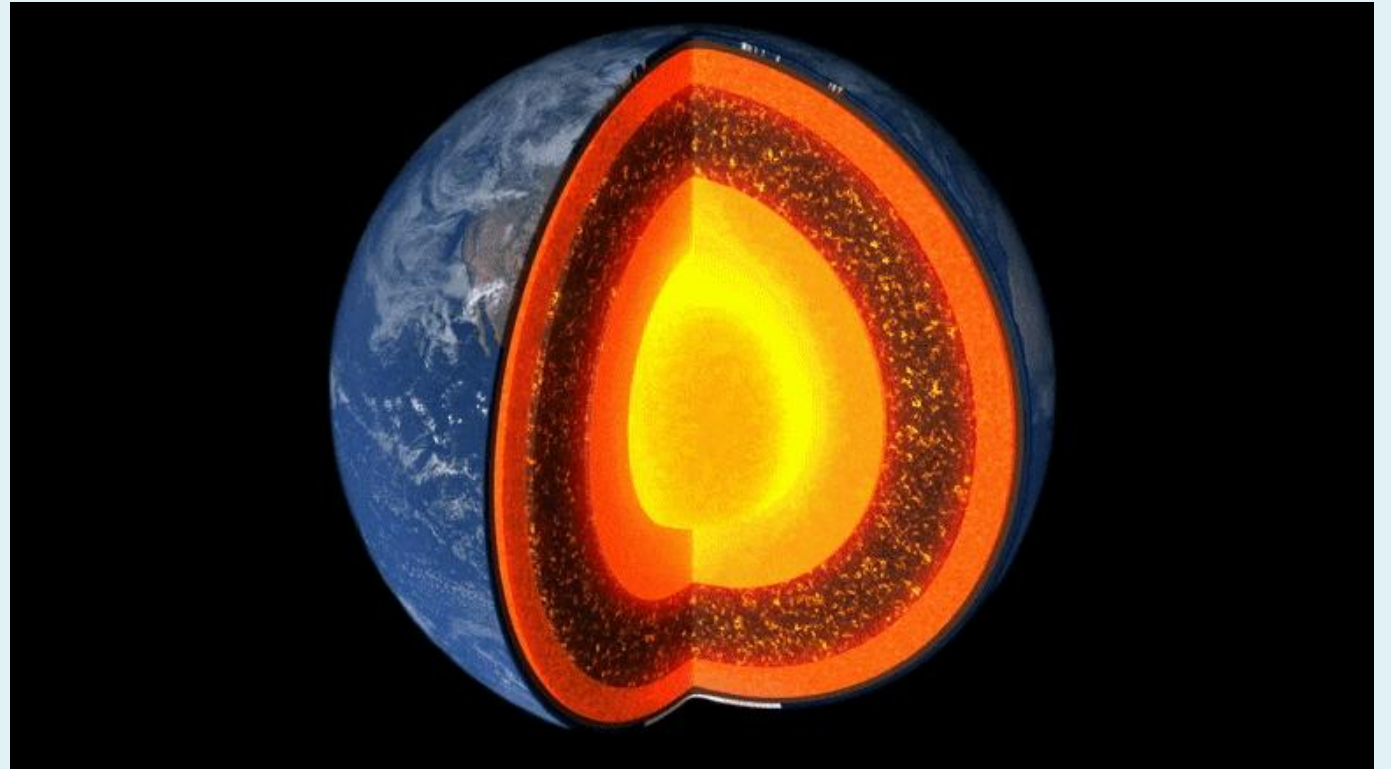
Print today's **Journal**
(or keep it open in a browser)

Do journal entries and problem answers on paper (space in the **Journal** is provided), in your own handwriting



Journey to the Centre of the Earth

*How can scientists know
what is inside the Earth,
when no one has ever been
there?*



Today's journey

1 How big our planet actually is

2 What is inside Earth — the layers

3 How we know, without ever going there

4 Pressure, and melted rock

5 Volcanoes, and the rocks that cool from fire

6 Density: why one rock can float

Our planet: size and shape

- Earth is almost a **sphere** — but not exactly
- It bulges a little at the equator: about 43 km wider than pole to pole
- From the surface to the centre — the **radius**: about **6,400 km**
- All the way round the **equator**: about **40,000 km**



Remember the units

1 km = 1,000 m. So 40,000 km is 40 million metres.

40,000 km — how far is that, really?



4500 km

Vancouver → Toronto road trip

$$40,000 \div 4,500 \approx 9$$

Once around the Earth = about 9 Vancouver-to-Toronto trips

How long is one trip around the equator?



How long is one trip around the equator?

$$\text{time} = \text{distance} \div \text{speed}$$

$$\text{days} = \text{hours} \div 24$$

Walking

5 km/h

$$40,000 \div 5 = 8,000 \text{ hours}$$

$$8,000 \div 24 \approx 333 \text{ days}$$

Nearly a year of walking, and that is without ever stopping!

By car

100 km/h

$$40,000 \div 100 = 400 \text{ hours}$$

$$400 \div 24 \approx 17 \text{ days}$$

Without stopping, and without a single traffic light.

By plane

900 km/h

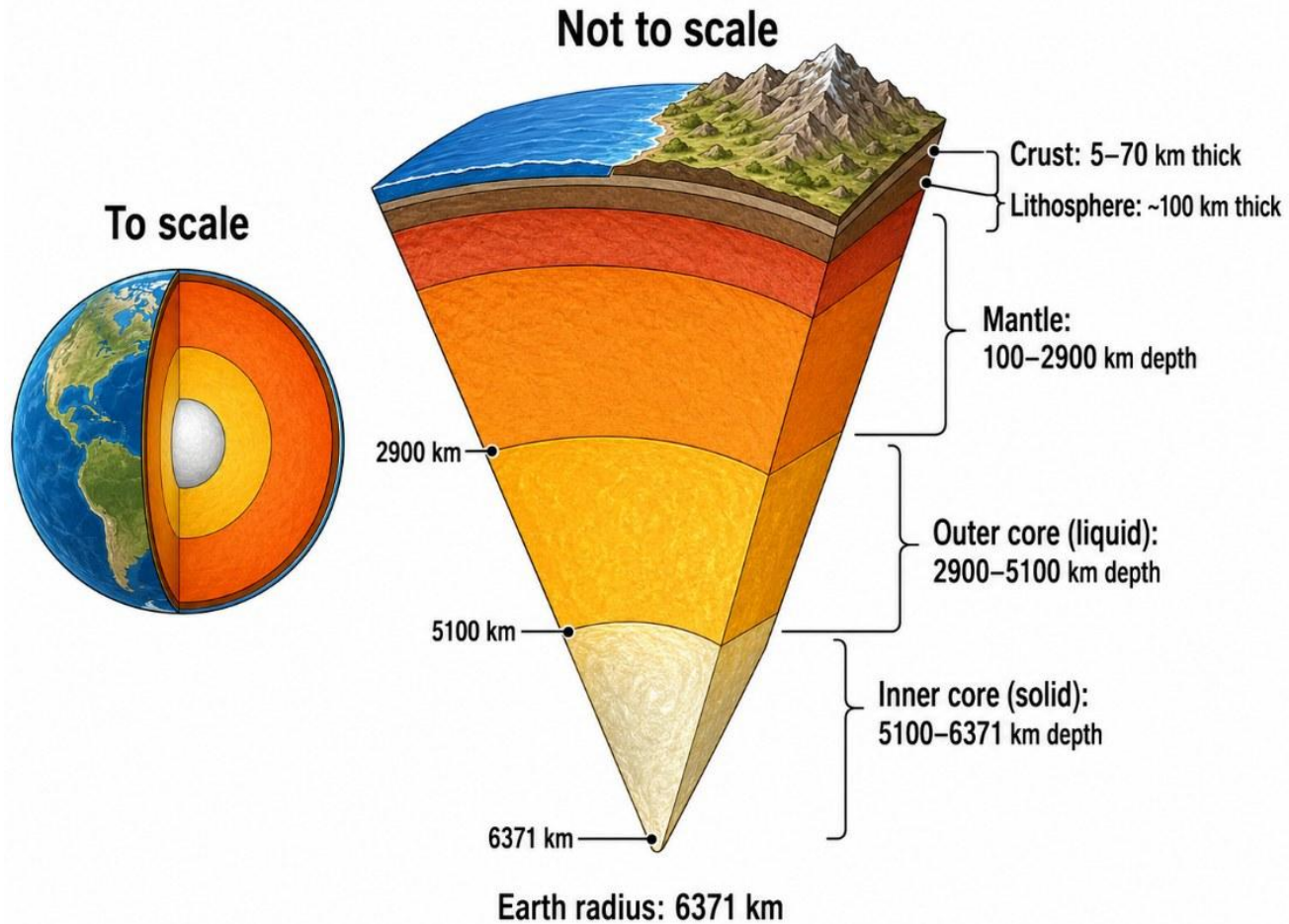
$$40,000 \div 900 \approx 44 \text{ hours}$$

$$44 \div 24 \approx 2 \text{ days}$$

Less than two days in the air — and that is around our whole planet!

Now let us look inside

The layers of the Earth



Crust 5–50 km — a thin skin of solid rock

Mantle down to 2,900 km — hot, mostly solid rock

Outer core liquid iron

Inner core solid iron, about the size of the Moon

The centre 6,370 km down, about 6,000 °C

How deep have people actually been?

$\approx 4 \text{ km}$

the **deepest mines** —
already too hot to work
without cooling machines
(about 65°C)

12.3 km

the deepest hole ever
drilled — Kola,
northern
Russia.
Twenty years of work

0.19 %

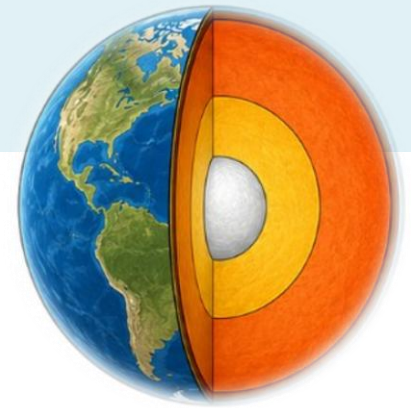
of the way to the centre (6400 km).
Everything below has **never**
been visited by anyone!

$$12.3 \div 6,370 = 0.0019 = 0.19 \%$$

*Everything we know about the rest was learned from
the **surface**. How?*

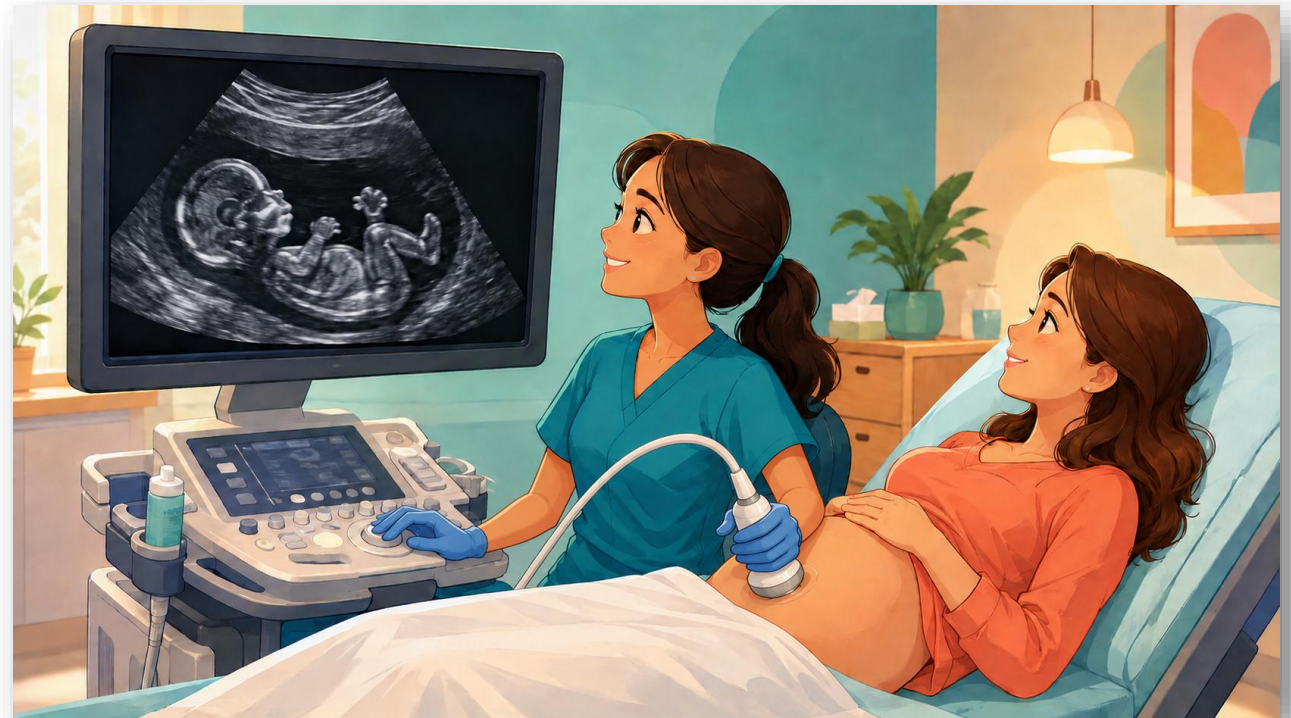


How do people know Earth has layers?



The answer: waves

- The same way doctors know what's inside the human body without getting inside
- The answer is **waves!**
- Send **waves** in, get **reflected waves** out, reconstruct the picture (which takes some complex math)
- **Ultrasound** and **MRI** in medicine

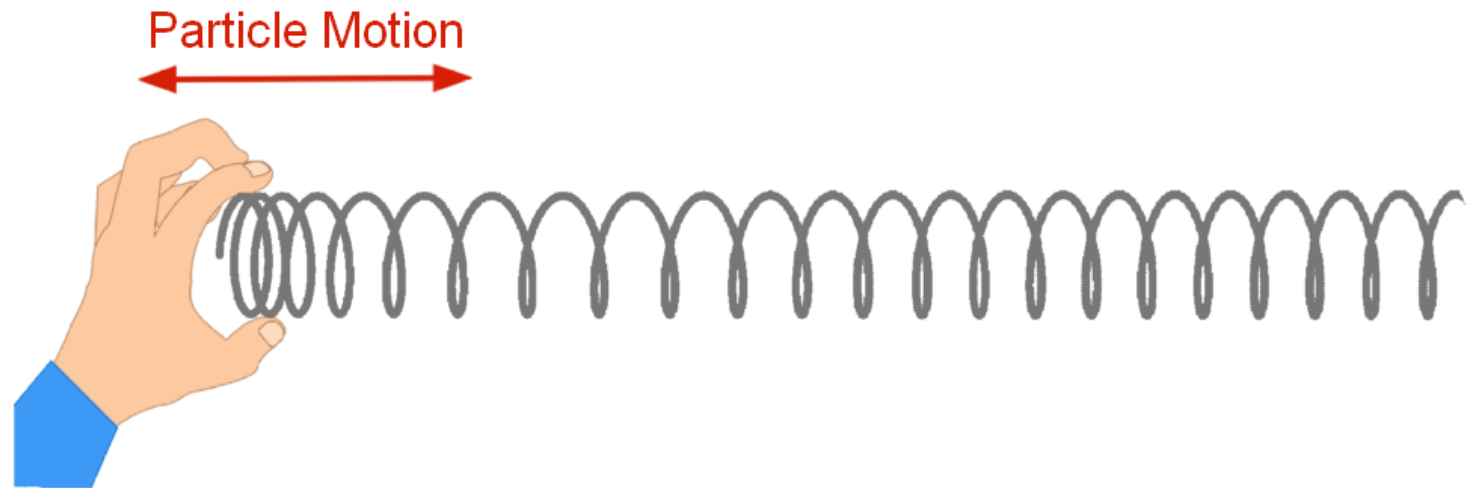


The answer: waves

P wave

A push and a pull, like sound.

It passes through solids and through liquids.

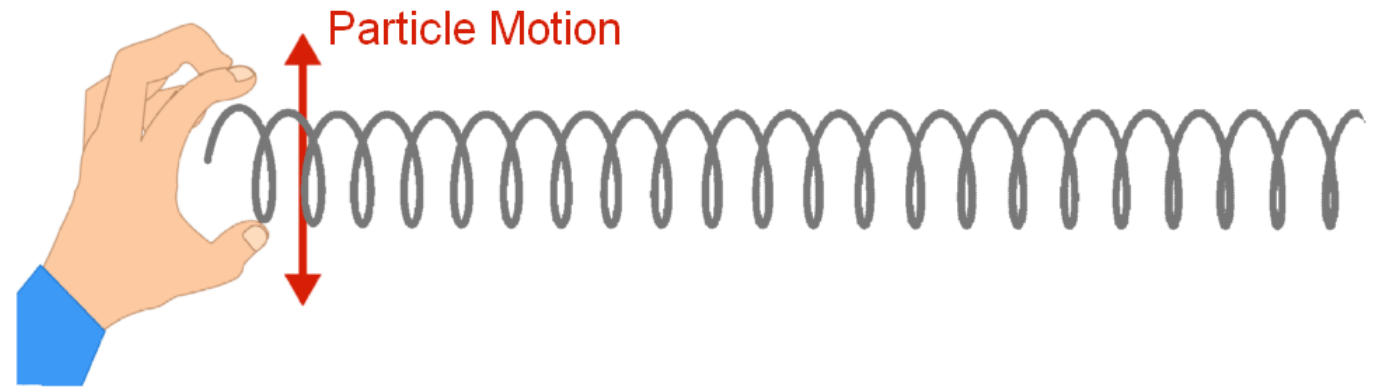


The answer: waves

S wave

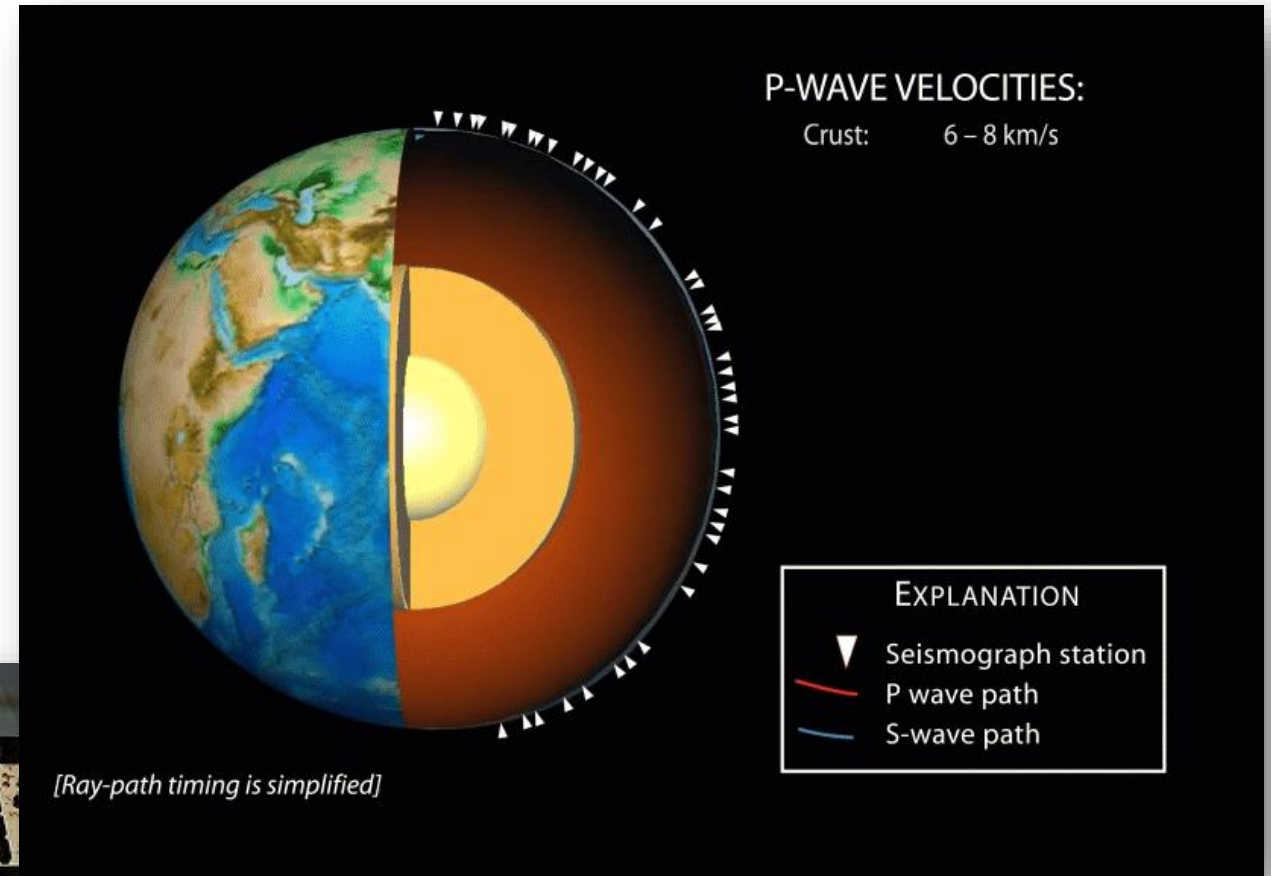
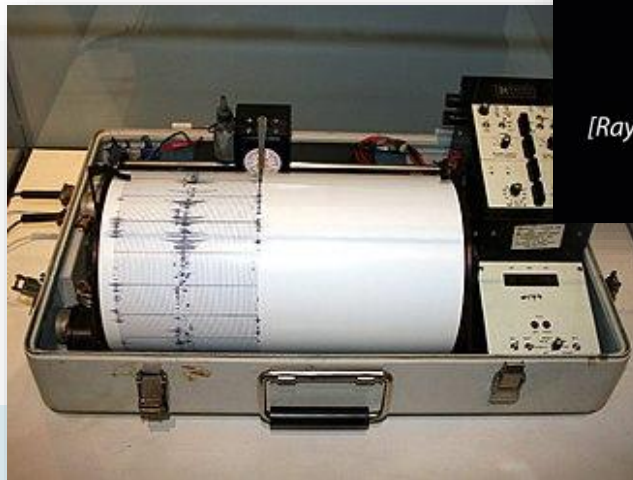
Side to side, like a wave on a rope.

A liquid does not spring back —
S waves stop at liquid.



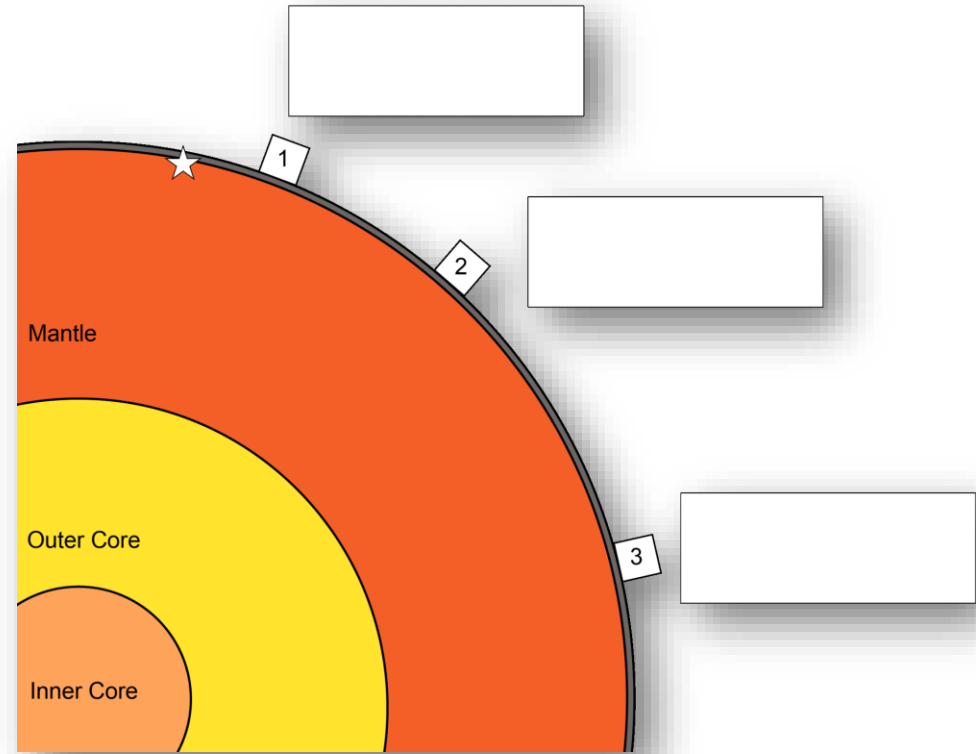
Who sends waves into Earth? Earthquakes!

- An earthquake shakes the whole body of the planet, not just the surface
- **Seismometers** all over the world record when each wave arrives
- A wave bends, or partly reflects, whenever the material changes — like light entering water
- Every bend marks a boundary between one layer and the next



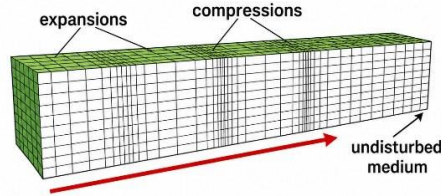
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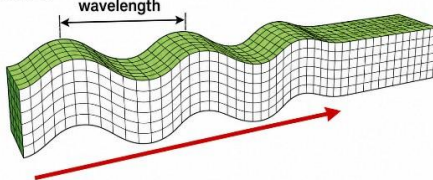


Two kinds of wave

P wave



S Wave

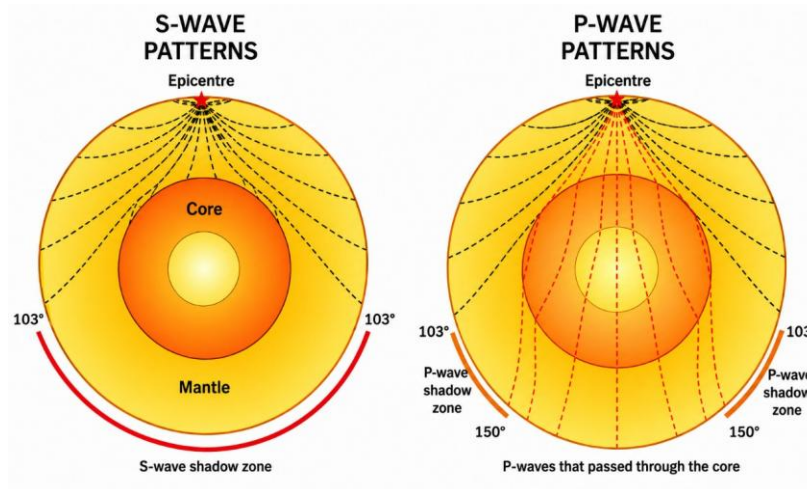
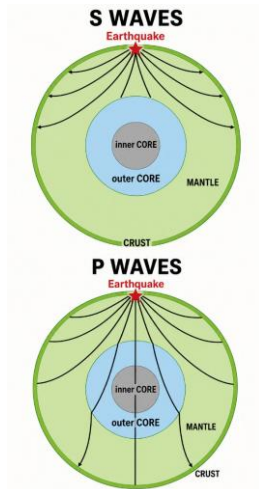


P wave

A push and a pull, like sound. It passes through solids and through liquids.

S wave

Side to side, like a wave on a rope. A liquid does not spring back — S waves stop at liquid.

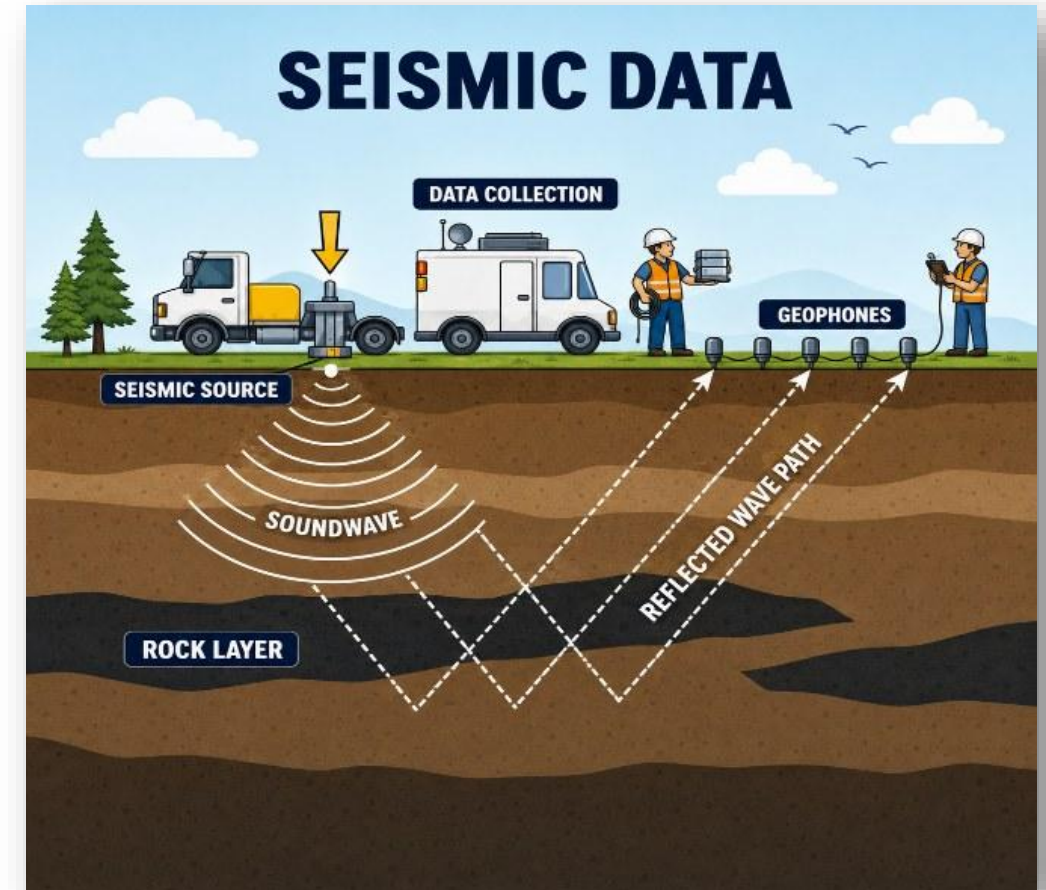


And that is how we know

On the far side of every earthquake there is a wide zone where S waves never arrive. Whatever stopped them must be liquid — the outer core.

We do not have to wait for earthquakes

- A survey truck presses a heavy plate on the ground and vibrates it
- A line of recorders on the ground times the echoes coming back
- A computer turns those times into a picture of the layers below
- Crews do this across Saskatchewan every year — it is how potash, oil and gas are found

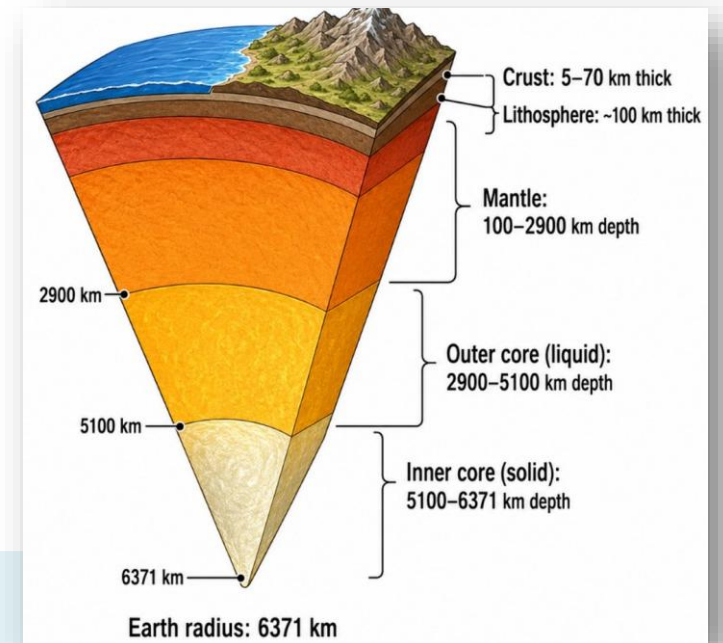


The mantle is not liquid — and the word “lithosphere”

- People used to think the mantle was liquid rock. It is not.
- It is mostly hot, elastic rock — and over millions of years it slowly circulates
- Only the outer core is truly liquid
- Where melted rock does appear, it acts as a lubricant between solid blocks

lithosphere

From the Greek lithos — stone. The rigid outer shell of the planet: the crust together with the uppermost, rigid part of the mantle.



Pressure: what is doing the pressing?

- Pressure is how hard something presses on each small piece of area
- Air at sea level: about 1 kg on every square centimetre — one atmosphere
- In water, every 10 m of depth adds one more atmosphere
- In rock it climbs about 250 atmospheres for every kilometre down

So how much, down there?

**$250 \times 12 = 3,000$ atmospheres at the deepest hole
at the centre of the Earth: over 3,000,000**

[video — pressure with depth: air, water, rock]

Experiment — the bottle that crushes itself

- 1 Add flammable gas, burn it
- 2 Cap it tightly
- 3 Watch. Nobody touches it — and the bottle collapses.

Why

The air inside cooled and pulled in. The air outside kept pressing — with the same 1 kg on every square centimetre.

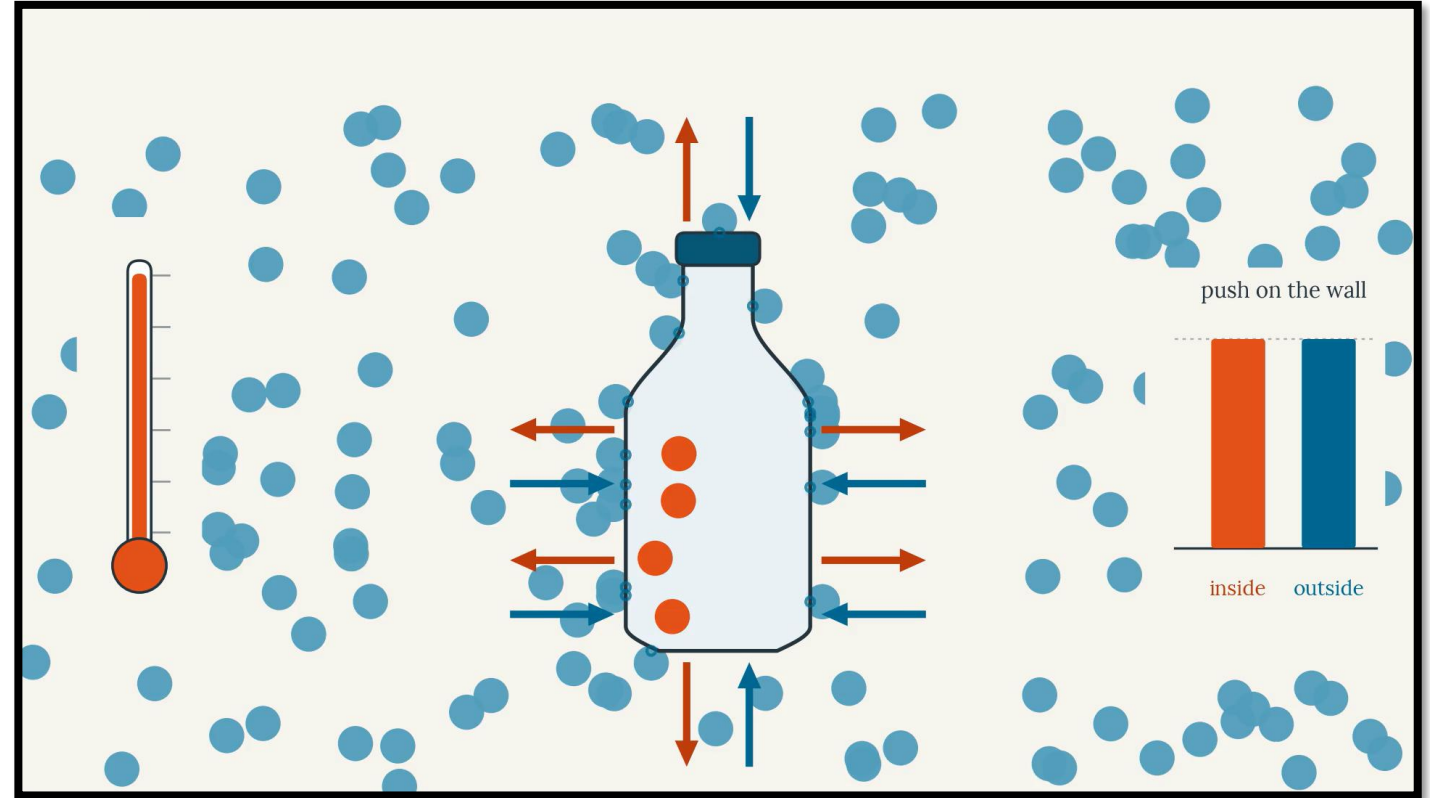
Safety: do not attempt it without an adult!



Experiment — the bottle that crushes itself

What happens:

Fewer air molecules colliding with walls from inside than outside, so the force from outside crushes the walls!



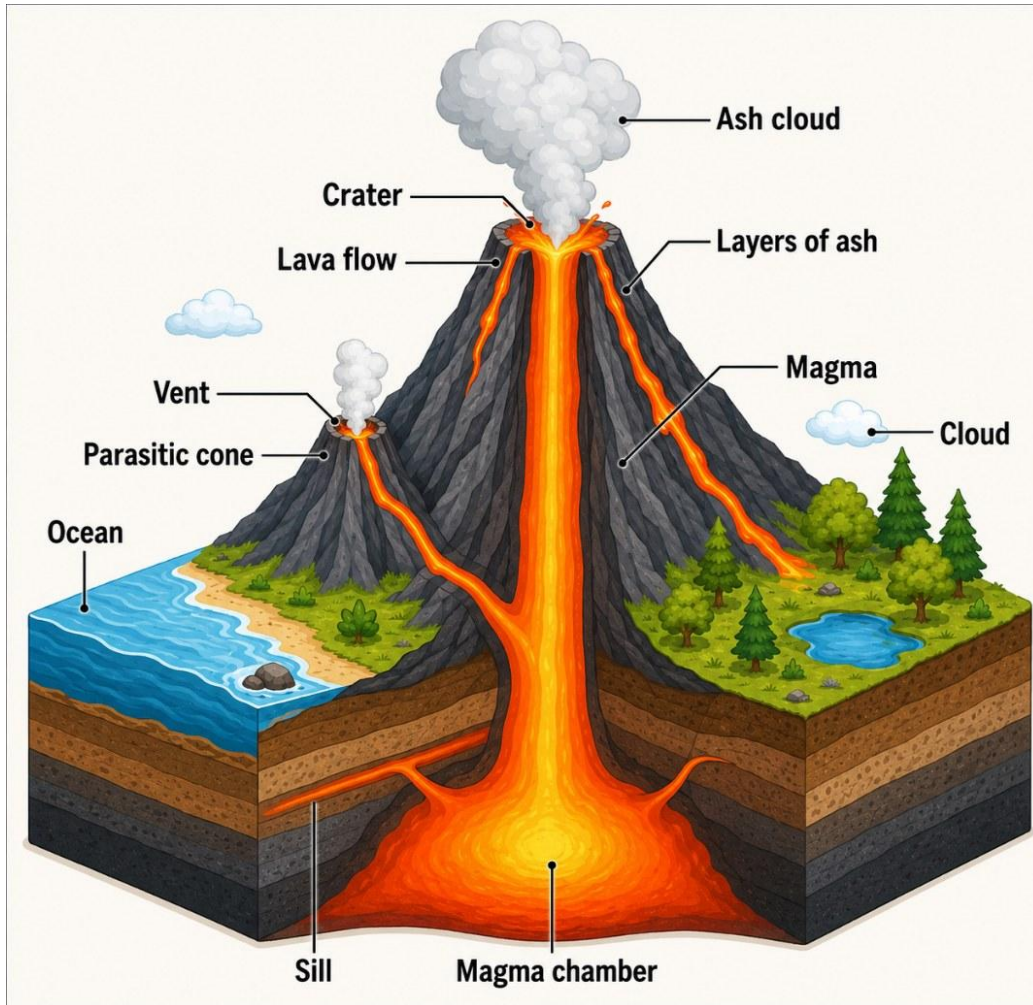
How big is the pressure deep inside?

PRESSURE INSIDE EARTH

The deeper we go, the more material presses down.



Volcanoes: where melted rock reaches the surface



- Melted rock underground is magma; on the surface it is lava
- Magma is pushed up by immense pressure below
- It gathers in the magma chamber
- A volcano is the mountain built up, eruption after eruption, from cooled lava and ash

Two very different ways out

A slow eruption

Runny lava, little trapped gas. It pours out and flows for days or weeks, building gentle slopes.



A blast

Sticky lava, gas trapped inside. Pressure builds until the rock above gives way — and ash is thrown kilometres into the sky.

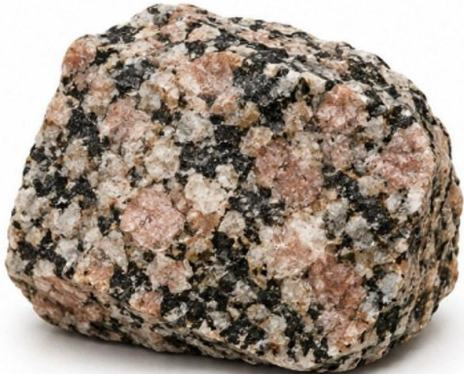


Pressure building up — then, explosion

- Gas is dissolved in the magma, held there by enormous pressure
- As the magma rises, the pressure on it drops
- Bubbles appear and grow — like opening a shaken bottle of fizzy drink
- Bubbles break, thick volcanic dust emerges



Igneous rock: written by fire



Granite

Cooled slowly, deep underground — grains large enough to see.



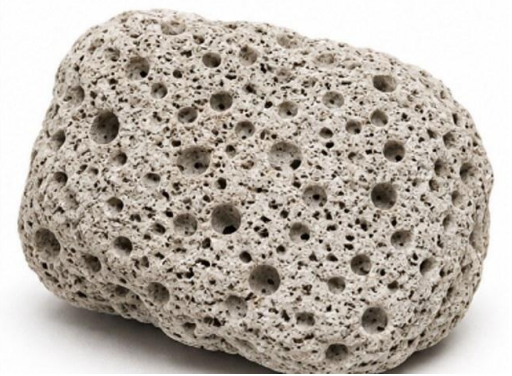
Basalt

Cooled quickly from lava. Most of the ocean floor is basalt.



Obsidian

Cooled so fast no crystals formed: natural glass.



Pumice

Froze full of gas bubbles — a rock full of holes.

“Igneous”: from Latin ignis — fire. The same ancient root in Sanskrit agni, fire.

Cooling leaves a clue

The rule

The slower the cooling, the larger the crystals. Slow cooling gives the material time to arrange itself into big, visible grains; fast cooling freezes it first.



Density: a number for every material

- Granite and pumice of the same size feel completely different in the hand
- The proper comparison is density: the mass of a sample divided by its volume
- We write it in grams per cubic centimetre, g/cm^3
- One cubic centimetre of water has a mass of one gram — so water is 1.0
- Below 1.0 floats in water. Above 1.0 sinks.

$$\text{density} = \text{mass} \div \text{volume}$$



Densities to compare

Material	Density, g/cm ³	In water
Pumice	about 0.3	floats
Water	1.0	the reference
Obsidian	about 2.4	sinks
Granite	about 2.7	sinks
Basalt	about 3.0	sinks
Iron	7.9	sinks

Lighter than water

Pumice is real rock, from a real volcano — and a dry piece dropped into a basin bobs at the surface. The trapped bubbles do it.



Now calculate it yourself

A rock sample

mass 300 g, volume 100 cm³

What is its density? Will it sink or float? Which rock from today could it be?

A piece of pumice

mass 50 g, volume 200 cm³

What is its density? What happens when you put it in water?

Now calculate it yourself

A rock sample

mass 300 g, volume 100 cm³

What is its density? Will it sink or float? Which rock from today could it be?

A piece of pumice

mass 50 g, volume 200 cm³

What is its density? What happens when you put it in water?

The answers — after you have tried

$$300 \div 100 = 3.0 \text{ g/cm}^3$$

heavier than water → it sinks

3.0 is basalt

Both of these are in your journal, with lines to write on.

$$50 \div 200 = 0.25 \text{ g/cm}^3$$

far lighter than water → it floats

Experiment — make a rock float

- 1 Drop a pumice stone into a bowl of water. Real rock, and it floats.
- 2 No pumice? Take two equal pieces of aluminium foil.
- 3 Crush one into the tightest ball you can. Shape the other into a big hollow ball full of air.
- 4 Put both in water — then squash the floating one and test it again.

What it shows

Empty space lowers the average density of an object made of dense material. That is the secret of pumice.

Before you finish — check yourself

- ☐ I can name the layers of the Earth in order, and say which one is liquid
- ☐ I can explain what the lithosphere is
- ☐ I can explain how waves reveal layers no one can visit
- ☐ I can explain why granite has large crystals and obsidian has none
- ☐ I can calculate a density from a mass and a volume, and say whether it floats

Next class

Class 2 — Rocks from Pieces, Rocks Transformed — and Crystals

- How sand and mud turn into solid stone
- What heat and pressure do to a rock that never melts
- Crystals — how they grow

READING MODULE 2 · WEEK 1 · CLASS 2

Rocks from Pieces, Rocks Transformed

Two more rock families — and the hidden order of crystals



See you next time!

