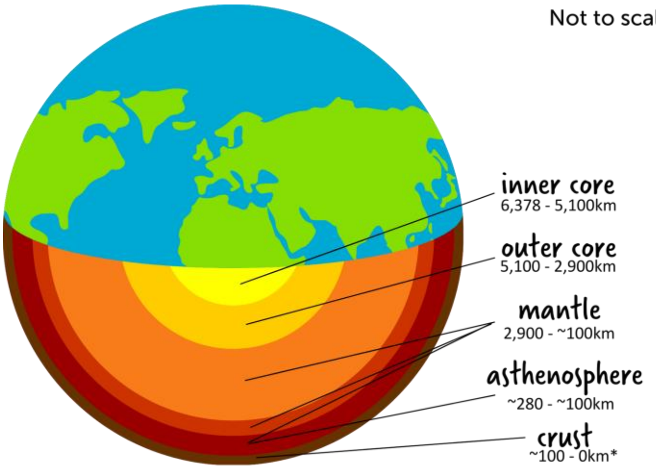
Layers of the Earth Teacher's Notes

All matter which forms our planet Earth was first created in ancient stars from the original hydrogen present at the beginning of the Universe. Fusion has turned this simple gas into more complex elements. Our planet system coalesced from a great cloud of gas and dust spinning round in the gravity field of our Sun.



Layers of the Earth (AusEarthEd, base graphic via Canva license)

During the formation of the Earth, various processes moved denser materials to the core and lighter to the **crust**. Less dense minerals, such as silica and aluminium, form the continental crust (sial) whilst the slightly denser oceanic crust is rich in silica and magnesium (sima).
Sialic rocks are predominantly granites (felsic). Western Australia has some examples of these earliest crustal rocks in the east Pilbara, Youanmi and in the Southwest. A detrital (weathered and eroded) zircon from the Jack Hills formation has been dated as 4,400 to 3,900 Ma old. This zircon, now found in a conglomerate, was likely part of some of the earliest rocks on the planet. Most crustal evolution (87%) took place before Precambrian times (542Ma).
Simaic rocks are predominately basaltic (mafic). These are some of the rocks which give the mineralised "greenstone" belts running north to south through Western Australia's ancient granites, their dark olivine colour.
The base of the crust is marked by a sudden change of density. This is named the "Moho" or **Mohorovičić discontinuity** after its Croatian discoverer. We know the composition of the Earth's crust by examining samples from at or near the surface.

Beneath the crust lies the **mantle**. It is also layered. The uppermost layer, together with the overlying crust is called the lithosphere and is broken into plates which float or drift on the molten **asthenosphere**. The lower mantle is very dense due to the pressure of the mass of rocks above. The mantle is ~2,900 km thick and takes up 70% of Earth's volume.
We use experiments of the effect of pressure on upper (shallow) mantle minerals to predict lower mantle composition. Ultramafic rock, rich in iron and magnesium, such as peridotites, are believed to be here. The lamproites which host Argyle diamonds originated here.
These inferences are supported by information gained in the transfer of seismic waves. The mantle is separated from the core by the **Gutenberg discontinuity**.

The **core** which is very dense and rich in iron and nickel, has a liquid outer layer and a solid inner layer. In the Earth's core the temperature (~6,000°C) and pressure (more than 3 million times the pressure of the atmosphere). This core is responsible for the Earth's magnetic field, which protects us from solar and cosmic particle radiation, as well as solar winds.

Most of our understanding about the composition of the layers of the Earth is gained from interpreting seismic results. Seismic waves travel at different speeds through different rocks. There are sharp differences in seismic wave velocities at specific depths. There are two different forms of seismic waves: S waves are shear waves (or secondary waves) which travel at slow speeds. Since they can only travel in solids they cannot travel through the core. P waves are primary or compression waves, they travel fastest in liquids.

S = Slow in Solid
P = comPression in liquid

Information on the structure of the Earth can be gained from the Australian Museum site at:
https://australian.museum/learn/minerals/shaping-earth/structure-and-composition-of-the-earth/

The overall composition of the Earth is similar to that of meteorites as they are remnants of the original dust cloud.

The BBC has produced a fantastic interactive on the depths of the ocean and Earth, which highlights the layers of the Earth as well - http://www.bbc.com/future/bespoke/story/20150306-journey-to-the-centre-of-earth/

Layers of Earth

- Students use teacher notes or textbooks to create an information sheet on the different layers of the Earth (worksheet provided)
- Each student or student group will need: a cork, some cooking oil, water, measuring cylinder, triple beam balance or chemical balance and a large beaker.
- Students estimate the density of the objects by dividing their mass by their volume (remind them to subtract the mass of the container when estimating for liquids).
- Students then place all three substances in the large beaker and see which floats on which and whether that relates to differences in density.

Graphing the composition of the layers of the Earth

For each student: Table (below), paper, pencil, coloured pencils, ruler, eraser, graph paper

	Continental crust	Oceanic crust	Mantle	Core
SiO_2	69%	48%	43%	
Al_2O_3	14%	15%		
$Fe_2O_3 + FeO$	4%	11%	12%	90%
CaO		11%	3%	
MgO		9%	37%	
NiO				8%

- Students copy the table above.
- Explain the 5 things every graph should have:
  1. Title (Comparing X with Y)
  2. Labeled axes
  3. Uniform scale
  4. Units on axes
  5. Accuracy (and completed in pencil)
- Discuss whether a line or bar graph would be most appropriate in this instance.
- Create graph and hand in.