Measuring the depths of seas and oceans: How is it done?
A simple demonstration of how we measure sea floor depths and relief

When sailors first wanted to measure the depths of the seas or oceans, all they could use was a lead weight on a long length of rope to 'sound the depths'. These lines were marked off at intervals and the 'linesman' would call out the depths as the line ran through his hands until it struck bottom – so 'plumbing the depths' (*plumbum* is Latin for lead). This 1555 drawing by Olas Magnus shows this in action.

From Olaus Magnus' Historia de Gentibus Septentrionalibus; woodcut in the public domain.

Ships used this to avoid shipwreck in shallow waters. The method was later used by scientists to begin mapping the ocean floor. However, it took a lot of time for one sounding of the ocean floor and was not very accurate for great depths. So, for a long time nobody had any real idea of the shape or relief of the ocean floor.

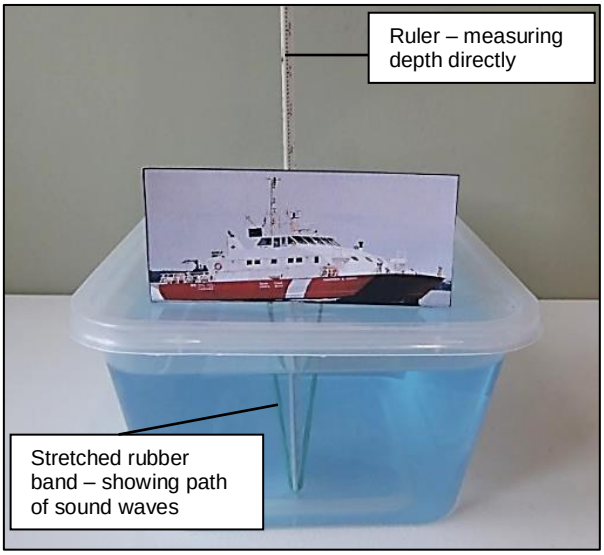
Echo sounders were first used in the 1920s for measuring the depths of the sea and detecting other ships or obstacles, and were very important during the Second World War. They send out a sound wave into the sea towards the sea floor or an object, and time how long it takes for the 'ping' to be returned. You can use this time to calculate the depth, if you know how fast sound travels in water.

This photo shows an echo sounder plotting a profile of a sea floor.

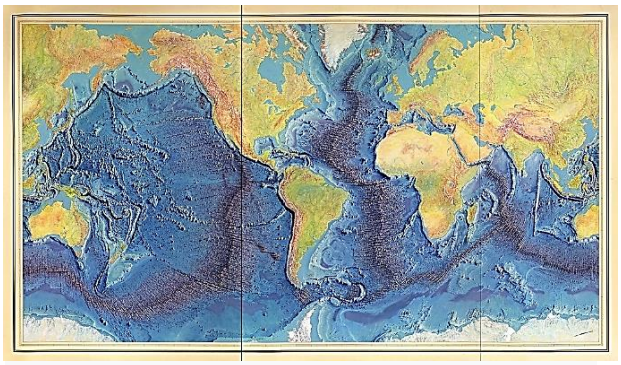
Echo sounder by Mredmayne released under the Creative Commons Attribution-Share Alike 3.0 Unported license.

The demonstration below shows how these methods work.

You could just measure the depth of this model ocean floor by using the ruler (simulating the sounding line method). But the stretched rubber band represents a sound wave sent out by a ship, travelling to the sea floor and bouncing back to the surface. If you measure the time it takes for the sound to go out and bounce back, and then halve this time (because of the two-way travel of the sound), you can calculate the depth, knowing that sound travels in sea water at about 1500 ms^{-1}.



This echo-sounding method is called sonar. Through using sonar we can now produce detailed maps of the ocean floor, like the one first published in 1977. This amazed the public when it appeared because many people, up to that time, had thought the sea floor was flat and had no idea that it had great mountain ranges, rift valleys and deep ocean trenches.



Painting of the ocean floors by Heinrich Berann based on echo sounding profiles of Marie Tharp and Bruce Heezen (1977).

Image available under the Creative Commons CC0 1.0 Universal Public Domain Dedication.

The back up

Title: Measuring the depths of seas and oceans: How is it done?

Subtitle: A simple demonstration of how we measure sea floor depths and relief.

Topic: Demonstrating ancient and modern methods of measuring and profiling sea and ocean floor depths.

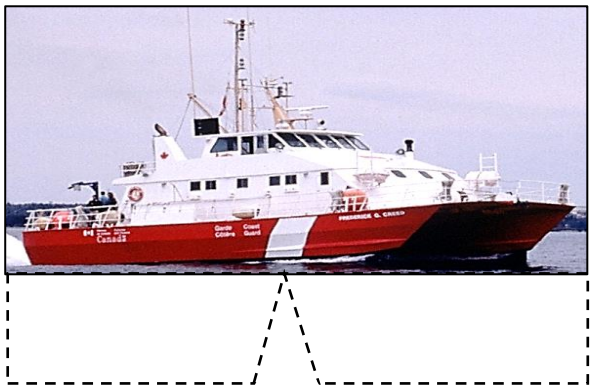
Age range of pupils: 8 years upwards

Time needed to complete activity: 5 minutes

Pupil learning outcomes: Pupils can:

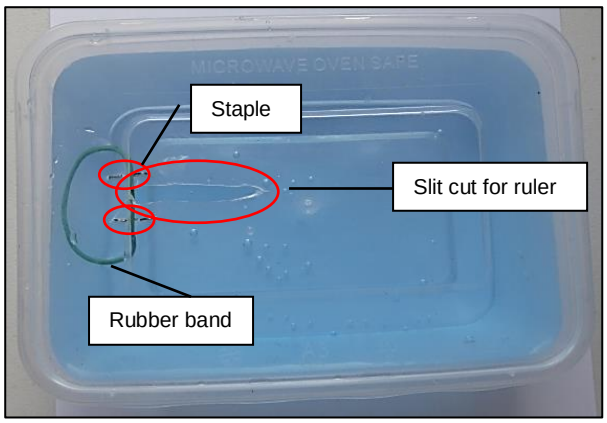
- explain how sea and ocean floor depths:
  - were originally measured;
  - are measured by sonar today.

Context:
Prepare the box as shown by using a sharp knife to cut a ruler-sized slit in the lid. Staple a rubber band in place by using two staples on either side of one end of the slit around 2.5 cm apart. Cut out this picture of a ship and stick it in position so that it stands vertically.



Canadian hydrographic survey vessel CCGS Frederick G. Creed in the public domain.

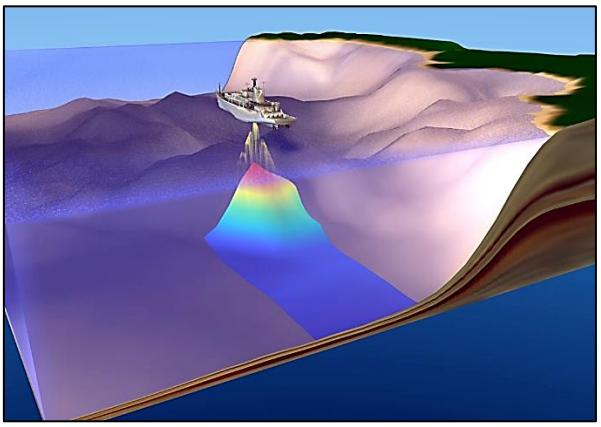
Fill the box with water, adding a little food colouring to make the water more visible. Then push the ruler vertically down into the slit, pushing the rubber band down with it.



The stretched rubber band shows how the 'ping' of an echo sounder travels between the ship and the ocean bed..

The set up – seen from the corner:

The diagram below shows how profiles of the ocean floor are measured today. Modern echo sounders map a band of ocean floor as they travel across the sea surface above.



An oceanographic survey ship mapping the ocean floor today.

From http://www.navy.mil/view_image.asp?id=2767 and released by the US navy into the public domain.

This demonstration activity is one of four linked Earthlearningideas on seafloor mapping, shown in the table on page 3.

Following up the activity:
Try one of the other seafloor mapping Earthlearningideas listed in the table.

Underlying principles:

- Seafloor depths used to be measured directly using weighted sounding lines.
- Nowadays, seafloor depths are measured by echo sounders which emit soundwave 'pings' into the water and measure how long the echo from the sea floor takes to return.
- The depth is calculated from half the travel time, given that the speed of sound in water is 1500 ms^{-1}.
- Continuous sea floor profiles can then be plotted by 'pinging' the sea floor at intervals.

Thinking skill development:
Using the activity to show the pattern of sea floor measurement involves construction. This is then bridged to reality.

Resource list:

- transparent plastic box with lid
- sharp knife to cut 'ruler slit'
- scissors to cut out boat photo
- Blu tac™ to stick down boat cut out
- rubber band
- stapler to staple rubber band
- ruler
- water and food colouring

Useful links:

See the other three related Earthlearningideas on seafloor mapping.

See animations of how seafloor mapping works by putting 'sonar mapping' into a search engine like Google™ and clicking 'videos.

Source: Chris King of the Earthlearningidea Team.

The Earthlearningidea ocean floor mapping activities	
Measuring the depths of seas and oceans: How is it done? A simple demonstration of how we measure sea floor depths and relief	https://www.earthlearningidea.com/PDF/350_Sea_floor_mapping1.pdf
Modelling seafloor mapping: How to simulate an echo sounder study of seafloor topography	https://www.earthlearningidea.com/PDF/351_Sea_floor_mapping2.pdf
Sounding the Pacific Ocean: An echo sounder traverse of the eastern Pacific	https://www.earthlearningidea.com/PDF/352_Sea_floor_mapping3.pdf
Marie Tharp: 'The valley will be coming up soon'. Bruce Heezen: 'What valley?' A woman scientist in a man's world – what was it like?	https://www.earthlearningidea.com/PDF/353_Sea_floor_mapping4.pdf