Continental split – the opening of the Atlantic Ocean
Modelling how the continents moved, from Pangaea to today

Ask your pupils if they have ever seen an animation that shows how Pangaea (the supercontinent that existed about 200 million years ago) split into the continents forming the Atlantic Ocean between them. If they have never seen an animation like this, type “Pangaea animation” into any search engine like Google™ to show them a good animation in action. Ask them to look carefully at the opening of the Atlantic Ocean between, on one side, North and South America, and on the other, Europe and Africa.

Ask them:
- how do they think that the geoscientists found the exact route followed by each continent;
- how geoscientists found out the exact position of the continents at each moment in time;
- if it is possible to calculate the average speed of the continents as they moved apart?

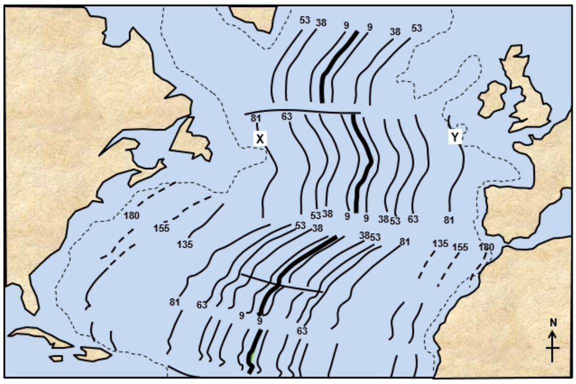


Figure 1. The North Atlantic Ocean showing isochrones. The edge of the continental shelf is shown by a dashed line.

Figure 1 shows the pattern of the isochrones (lines joining points of the same age in millions of years - Ma) across the Northern Atlantic Ocean. Explain to your pupils that the ages of the basalts in the ocean floor have been obtained from radiometric dating – a technique which works especially well for magmatic rocks like basalts.

Give out a photocopy of page 3 containing the two maps to each pupil in the class. Ask them to work together in groups of three. Each person in each group should cut the two maps along different isochrones, eventually producing six maps cut along different isochrones. So, for each map they should:
- cut along the two isochrones of the same age on both sides of the oceanic ridge;
- remove the central strip of paper between the two isochrones;
- slide together the two resulting pieces of map, trying to fit them together (the resulting pattern rebuilds the oceanic ridge at that time, as well as showing the relative positions of the continents on both sides of the ocean).
- not “forget” Greenland when cutting the maps.

Once the groups have cut their six maps, they should sort them into time order to show the steady opening of the Atlantic Ocean.

NOTES
- In order to model the relative movements of the continents, ask them to sort the images from the *oldest* to the *youngest* (if they sorted them in reverse order this would show a *rewinding* of the movement).
- Pupils should be aware that despite the fact that only one new ocean forms, there are more than two tectonic plates involved in this process (the North and South American plates are on one side, with the Eurasian and African plates on the other, with some minor plates as well). This means that, the fit for the older isochrones is not very good; however, this can be improved by “cutting” and moving the Eurasian and the African plates independently.

………

The back up
Title: Continental split – the opening of the Atlantic Ocean.

Subtitle: Modelling how the continents moved, from Pangaea to today.

Topic: A scissors and paper activity modelling the relative positions and movements of the continents as the ocean floor spreads either side of an oceanic ridge.

Age range of pupils: 14-18 years

Time needed to complete activity: 30 minutes

Pupil learning outcomes: Pupils can:
- Describe how new oceanic lithosphere is created as tectonic plates move apart.
- Explain that oceanic lithosphere is mainly made of basaltic rocks.
- Explain that not all the sections of oceans opened at the same time (i.e. the South Atlantic began to open before the North Atlantic)
- Relate the age of the ocean floor to the movement of plates and, subsequently, of continents.

Context:
This activity could be used in any science or geography lesson about sea floor spreading and Wegener's concept of continental drift.

Following up the activity:
- Higher ability students could be asked to work individually with just one map. They should cut the isochrones from the youngest to the oldest, take photographs after each cut and display these in a poster (again in the opposite order to the one they took the pictures!).
- With the help of the distance given in the caption, ask your students to calculate the average spreading speed between the 81Ma isochrones between X and Y, over the past 81 million years.
  A. The approximate rate at which the ocean is widening is:
  2400km/81Ma = 29.6km.Ma^{-1} = 29.6mm.y^{-1} or 1500 miles/81Ma = 18.5miles.Ma^{-1} = 1.17in.y^{-1}.
  The mean spreading speed of each individual plate is half this rate.

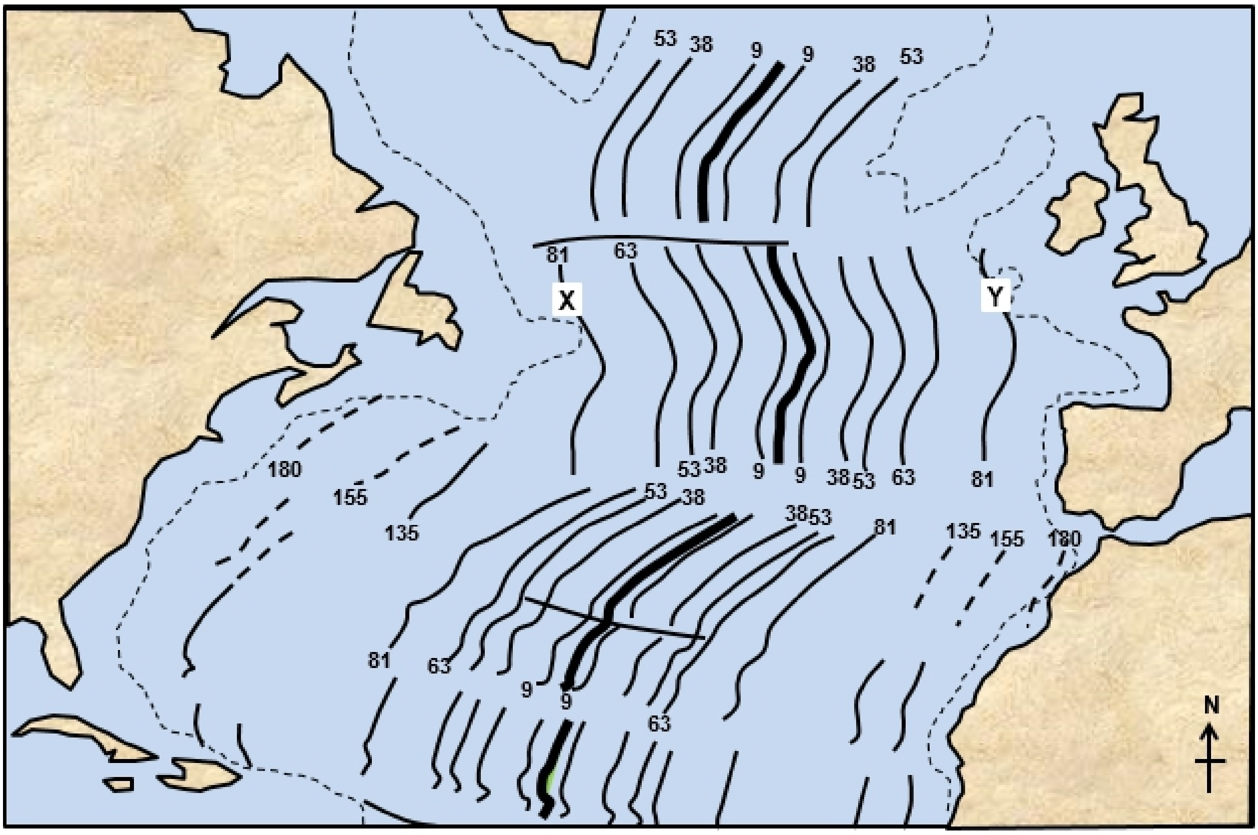
Underlying principles:
- As new plate material is formed at oceanic ridges, sea floors spread apart.
- The surface of the newly-formed plate material is mostly basaltic – igneous rock.
- Radiometric methods – based on the decay of radioactive isotopes – are used to determine the age of igneous rocks like basalts.
- When displayed upon a map of the ocean floor, the ages of rocks (basalts) show a clear pattern, with symmetrically increasing ages from the oceanic ridge towards the continents on both sides.
- "Virtually" removing the area between the two isochrones of the same age on both sides of the oceanic ridge allows scientists to show the relative positions of the continents at that time.
- The oldest rocks in each section give an approximate idea of the time when the ocean began to open in that area.

Thinking skill development:
Pupils build their own pattern of the ages of rocks across the ocean. The differences between ages in different cross sections across the ocean produce cognitive conflict. Relating the ages of rocks to the relative movement of continents involves bridging skills.

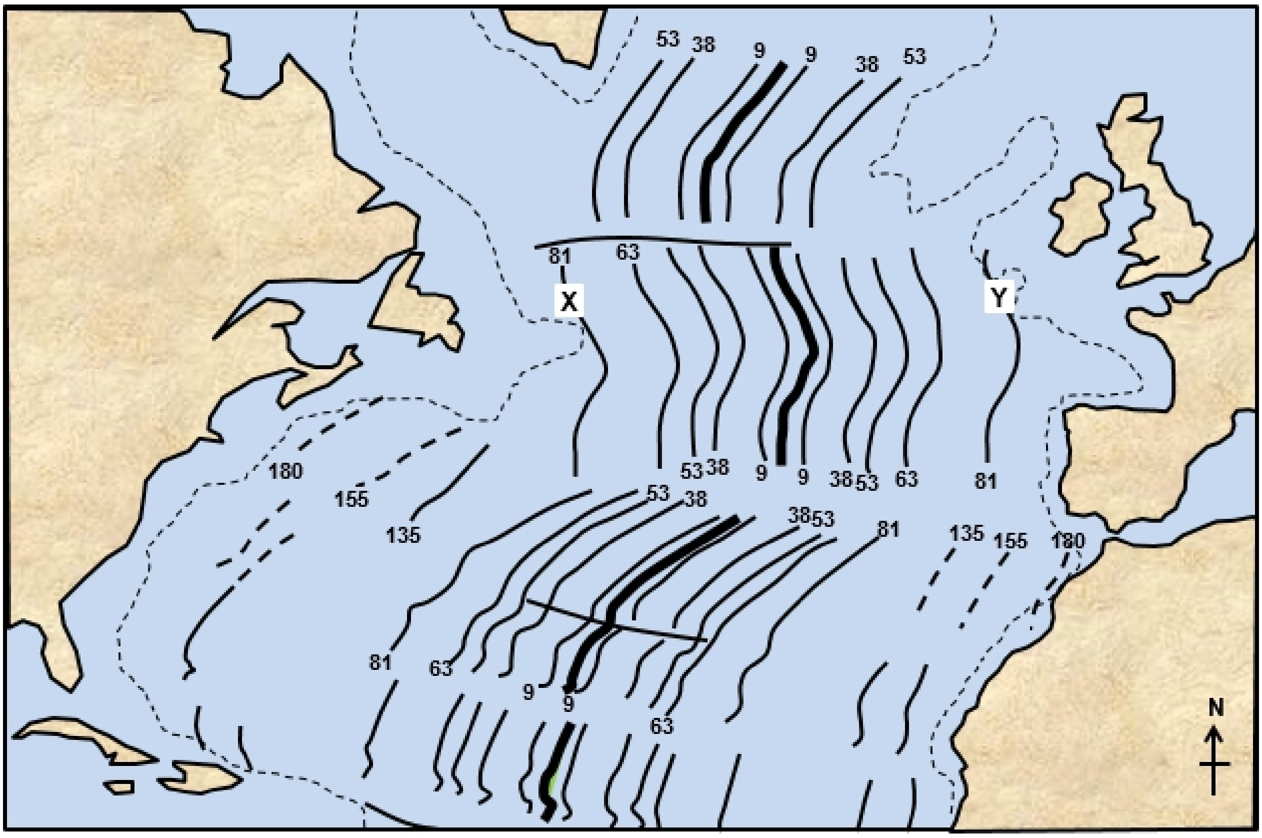
Resource list:
- two photocopies of the maps on page 3
- scissors
- (optional) a camera
- (optional) ruler (if they are to calculate the average speed of the plates)

Useful links:
Try the ELI activity: *Magnetic stripes - Modelling the symmetrical magnetic pattern of the rocks of the sea floor*.

Source: Devised by Xavier Juan, Spanish and Catalan translator of the Earthlearningidea Team. The map is redrawn, with permission, from the following scientific paper: Pittman, W.C., III and Talwani, M. 1972. Sea-floor spreading and the North Atlantic. *Geol. Soc. Am. Bull.*, **83**: 619-246.



The North Atlantic Ocean showing isochrones (lines of equal ocean floor age). The edge of the continental shelf is shown by a dashed line. The distance between the 81Ma isochrones between X and Y is approximately 2,400 km (1,500 miles).



The North Atlantic Ocean showing isochrones (lines of equal ocean floor age). The edge of the continental shelf is shown by a dashed line. The distance between the 81Ma isochrones between X and Y is approximately 2,400 km (1,500 miles).