Primary & Secondary Data Collection - Teacher Notes

Modern scientific theory relies on the collection of supporting data that is observable, measurable and repeatable. The explanations of how mountains were raised, volcanoes erupt and the Earth's surface changes have adjusted and improved over the years as more information (data) becomes available and technology improved.

Primary data is data collected by the observer such as measurement of the magnetic dip and orientation of rocks from India and Australia. In the picture, the rock in the geologist's hand is sufficiently magnetic to attract the swinging magnet. Since the geologist is collecting the data themselves, the data is primary

Secondary data uses observations collected by another. You can compare the photograph of Permian Gondwanaland leaf fossils (left) found in rocks near Mingenew in the Central Midlands of WA with the photograph of fossils from rocks of the same age (right) in Victoria. Since the photographer selected the information it is secondary data.

Proxy data uses data collected for another purpose from which i*nference* can be made. This photograph was made during a tourist trip near Coalseam Reserve in our Central Midlands of WA. The long parallel scrape marks apparent on the surface of this stone were probably caused by ice dragging it over others. They look like those seen elsewhere in the world where glaciers are presently retreating, dropping stones marked like these. Therefore it can be inferred that the Central Midlands must have been under ice and its rocks scraped by ice in the past. Furthermore, striae radiate outwards from the centre of an ice cap so the location of the South Pole can be inferred for that time.

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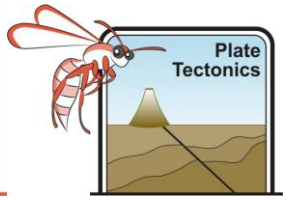


Continental Drift Theory suggests that at various times the continents of Earth have come together to form supercontinents and then split up only to reassemble again later. Pressure on the crust when they moved together created mountains. Although some evidence to support this lay in the study of geology, palaeontology and geography much of early theory relied on inference. It wasn't until the 1950s that it was possible to collect primary data to support both the theory and to suggest the process that powered movement. The original concept developed into Plate Tectonic theory. More recent data from modern geophysics, radiometric dating, and satellite imaging can measure these changes. Our continents ***are*** moving and have done so over the last 3.8million years.

Early theories and beliefs to explain the formation of mountains
Explanations of how mountains were raised, volcanoes erupt and how the Earth's surface changes have been adjusted and improved over the years as more information (data) becomes available and technology improves.

Beliefs
Aboriginal people believed that dreamtime spirits shaped Earth's surface. Many stories tell of a rainbow serpent whose body made valleys and pushed up mountains as he moved across the land. Early European thinkers tried to relate Earth movements (diastrophism) to Noah's flood and other biblical events.

Which of the following theories relied on primary data, secondary data or proxy data?

In the 15th century, Giardano Bruno realised that had Earth cooled down after its initial molten phase. He proposed that mountains were wrinkles caused by shrinkage due to cooling. (He compared Earth to a dried apple).

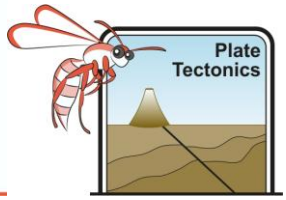
Data type Proxy data. He used the apple to infer what may have happened to the Earth

In 1620 the English scientist Francis Bacon was reviewing early seafaring maps. He noticed that the coastlines of Africa and South America appeared to fit together.

Data type Secondary data. He used maps prepared by others

In 1668 Francis Plaget suggested that the continents had been torn apart by Noah's Flood which he had read about in the Bible.

Data type Belief/secondary



In 1830 Charles Lyell noted changes in historical sea level in the sunken temple of Seraphis when he visited it. His careful mapping outlined a series of rises in sea level. He suggested that sudden changes could make land rise or fall without breaking buildings.

Data type Primary

In 1832 on the second voyage of the Beagle, Charles Darwin viewed and mapped raised land terraces in South America and suggested that such rises were not sudden and local as Lyell had suggested but could happen over large geographic ages. Later climbing in the Andes he noted a fossilized forest and beach at 2,100m above sea level suggesting that great rises could occur.

Data type Primary

In 1885 Austrian geologist Edward Seuss noted similarities between plant fossils in the southern continents and gave the name Gondwanaland to the super continent to which they might have belonged.

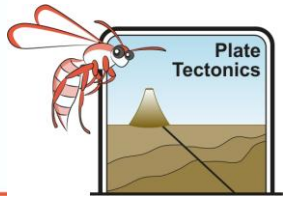
Data type Primary (in fact Edward only had sample of the Australian plants so primary and secondary (South Africa and South America))

Wegner's Theory of Continental Drift

In 1915 Alfred Wegner blended ideas from previous thinkers with some of his own and published *Continental Drift Theory*. This suggests that at various times the continents of earth have come together to form supercontinents and then split up only to reassemble again later. He suggested there was one great super continent called Pangaea (all earth). Pangaea split into a northern continent, Laurasia and a southern continent Gondwana. These again split up about 60 million years ago to form smaller continents that moved slowly to their present day locations

You will be assembling his supporting data (evidence) and attaching it to this worksheet. This activity is based on maps downloaded from the Earth Learning Idea web site. http://160.5.144.40/earthlearningidea/PDF/85_Continental_jigsaw_puzzle.pdf

1. Jigsaw fit of continental margins across the Atlantic. The fit is particularly close when the undersea continental shelf margins are used. Cut out along the east and west sides of the Atlantic Ocean and decide if the fit is sufficient to support Wegner's theory.



This evidence does/does not support Wegner's Theory of Continental drift because it infers that the two sides could have been joined together in the past.

2. Identical fossil plant and animal assemblages found on opposite sides of the Atlantic, as reported in many scientific papers, suggesting that the lands were joined. The southern continents could be re-assembled to form the supercontinent of Gondwanaland. (See second picture on first page)

Why did Wegner particularly select freshwater animals and land plants to use as evidence? Freshwater animals could not have survived in the sea. The lands must have been joined for them to have been spread across. Similarly, although it is possible for some seeds to drift across the sea, the width of the Atlantic and Indian oceans would have made this very difficult. Some opponents proposed thin land bridges which crossed the oceans.

This evidence does/does not support Wegner's Theory of Continental drift because It explains how such organisms could be identical across great stretches of ocean.

3. Reports of large-scale geological features that can be matched on either side of the Atlantic. E.g. The Karoo and Santa Catarina geological system

This evidence does/does not support Wegner's Theory of Continental drift because it demonstrates that identical climatic and geological processes were happening at the same time therefore they must have been close.

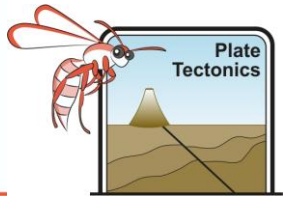
4. Evidence of glaciation in areas presently far away from the present poles. A "band" of glacial features such as U shaped valleys, drop stones and glacial moraines runs from South America, across central Africa, through North India and Southern Australia.

This evidence does/does not support Wegner's Theory of Continental drift because away from the poles glaciation only occurs in small patches on top of high mountains. These large glacial deposits suggest that all these areas must have been together near the pole.

5. Glacial scratches (striae) observed on rocks from the southern continents radiate out from a central point (South Pole) when the continents are fitted back together. (See third picture on first page)

This evidence does/does not support Wegner's Theory of Continental drift because present glaciers move away from the poles. As they move, the boulders they carry scratch rocks along their pathways. The marks of these scratches can be traced back to the heads of the glacier. If the continents were not together the marks do not make sense.

Given this evidence, would you have believed Wegner's theory? Explain your answer.
Any reasoned answer



Can you provide four pieces of scientific evidence to support the theory that you have been ***actively*** engaged in, in completing this worksheet. (***HINT OMMR***)

1. All the questions have been answered (observable, measurable)
2. I thought for myself and did not copy other's answers (observable)
3. I wrote all the answers myself/my handwriting (observable)
4. My reasons for each answer have been written (observable, measurable)
5. I have not left the room (observable)
6. I have/will have a good mark (observable, measurable)

Wegner's major weakness however was that he couldn't suggest a reasonable mechanism for driving continental movement and that his calculations for the rate of movement were too fast (250cm/year). He theorised that continents moved through the surface of Earth like giant snow ploughs under the gravitational influence of the Sun and Moon and "polar pull". Detractors suggested that land bridges had joined the continents allowing plants and animals to spread. Most particularly they mocked the ability of a meteorologist to understand geology.
By 1930 few geologists believed in Wegner's theory.
By the 1950s new technologies brought new evidence to support his theory and also suggest a better mechanism for moving continents. It was called Plate Tectonic Theory.