## *Teaching Activity: Moving Plates, Changing Climates*

***Introduction:*** We know from experience that weather changes from hour to hour and from day to day, but that climate seems to remain relatively unchanged. In truth, however, climates do change slowly over time. Within a relatively short period in Earth history, a region can go from having a temperate rain forest to a tropical desert. The question is, *What causes changes in climate?*

Climate is generally defined as the general conditions of temperature and precipitation over a region for a relatively long period of time (10-100years). Major changes in these long-term conditions appear to be caused by one or more natural factors: the slow drifting of the continental plates, changes in the Sun's energy output, and variations in the position of the Earth relative to the Sun. These natural factors are unrelated to human activity such as increased levels in greenhouse gas concentrations as a result of fossil fuel burning. Major climate changes in the past have had dramatic effects on the living environment, including a series of glacial periods (ice ages) and perhaps, the extinction of the dinosaurs. In order to be able to predict future climate conditions and their effects on the Earth and its living things, scientists must first understand the causes of past climate changes.

***Objective:***

- To plot the locations of earthquakes around the globe;
- To analyze fossil evidence and hypothesize regarding the events that determined their locations;
- To determine the arrangement of the Earth's continents in the past as a result of fossils evidence;
- To understand that the movement of the Earth's crustal plates over time has influenced regional climate conditions;

***Important Terms:*** Plate tectonics /continental drift, glaciation, Milankovitch theory, extinction, Glossopteris, Mesosaurus, Lystrosaurus, Pangaea, magnetic field, sea floor spreading, mid-ocean ridge, Ring of Fire;

***Materials:*** Blank world map, **Student Activity Sheet (Parts A,B, and C)**, colored pencils, scissors, glue, paper and pencil;

***Procedure:***

**Part A: Plate Tectonics:**

**Background:** Then interior of the Earth is made of molten rock called *magma.* Covering the surface of the Earth is a thin layer of land called the *crust* and is made of large sections called *tectonic plates.* These plates float on the surface of the magma and move with the energy from internal *convection currents.* Mineral deposits are formed in different regions of the Earth as a result of plate interactions and geologic forces. The plates can interact with each other in 4 different ways:

- **Sea floor spreading**: Molten material reaches the surface and moves two plates apart; new land called *mid-ocean ridges* are formed.
- **Transformed faults:** Two plates slide past each other; earthquakes are common with this type of fault; the San Andreas fault in California is an example.
- **Subduction:** One plate slide under another; pressure and friction cause the lower plate to melt, resulting in earthquakes and volcanic activity.
- **Plate collision:** Two plates collide head on; this causes uplifting which results in mountains rising and earthquakes.

Volcanoes are common along the boundaries of tectonic plates. Using the map coordinates that follow:

- Have students plot the locations of the volcanoes on the world map;
- Have students try to identify the "Ring of Fire", a zone of very active volcanoes.

| | | |
|---|---|---|
| **Western U.S.** | | |
| Lassen, CA | 40N | 121W |
| Crater Lake ,OR | 43N | 122W |
| Mt. Rainier, WA | 47N | 122W |
| Mt. Baker, WA | 49N | 122W |
| **Central America and West Indies** | | |
| Paricutin, Mexico | 19N | 102W |
| Popocatepetl , Mexico | 19N | 98W |
| Santa Maria, Guate, | 15N | 92W |
| Mt. Misery, St. Kitts | 17N | 63W |
| **Alaska and Aleutian Islands** | | |
| Katmai, AL | 58N | 155W |
| Adak, Aleutian Is. | 52N | 177W |
| Kamchatka, Russia | 57N | 160E |
| **Central Pacific** | | |
| Mauna Loa, Hawaii | 19N | 156W |
| Galapagos Islands | 1S | 91W |
| Mariana Islands | 16N | 145W |
| **Interior U.S.** | | |
| Yellowstone Pk. Wy | 45N | 111W |
| Craters of the Moon,ID | 43W | 114W |
| **South America** | | |
| Cotopaxi, Ecuador | 1S | 78W |
| Misti,Peru | 16S | 71W |
| **Japan** | | |
| Fuji, Honshu | 35N | 139W |
| **East Indies** | | |
| Mayon, Phillipines | 13N | 124E |
| Krakatoa, Java | 6N | 105E |
| Karkar, New Guinea | 5S | 146E |
| **South Pacific** | | |
| Auckland, New Zea. | 38S | 176E |
| Tahiti | 18S | 149W |
| Samoa | 13S | 172W |

**Part B: Evidence of Tectonic Movement:**

**Background:** The tectonic plates are not stationary. Based on scientific evidence, scientists agree that all of the continents were once joined together in a supercontinent called *Pangaea*. As a result of plate movements, the continents are in their present locations and continue to move at about 2 cm per year. The scientific evidence include fossils, landforms, rock layers, magnetic fields and glacial markings.

- Instruct students to study the information under **Evidence**.
  - In the space next to each item, they should write the implication the evidence presents in terms of their former locations and their relationships to each other.
- Students should then cut out the continents on the ditto sheet labeled **Part B.**
  - Students should move the pieces around until they achieve a1 location that supports the evidence.
  - Students should then paste the continents in place.

**Evidence #1:Glossopteris**-belonged to an extinct group of plants known as seed ferns. Although seed ferns had leaves much like the ferns of today, they produced seeds, not spores.

Fossils were found in Argentina, _____
South Africa, India, southern _____
Madagascar, central Antarctica, _____
and eastern Australia; also in _____
France, Russia and NE Siberia. _____

**Evidence #2: Glaciation** - occurred in cycles over the course of earth history beginning in about 350 M years ago;

Glacial deposits from 300 M yrs ago _____
covered large portions of south and _____
southeastern South America, the _____
southern half of Africa, Madagascar _____
India, the southern half of Australia _____
and the bottom half of Antarctica _____

**Evidence #3: Mesosaurus fossils**- Mesosaurus was a small lizard-like animal about 20 cm long that lived in shallow freshwater environments.

Water reptiles have been found in _____
both Brazil and Africa. _____
_____
_____
_____

**Evidence #4: Lystrosaurus fossils**- Lystrosaurus was a medium sized reptile that lived on land and ate the leaves of small deciduous trees and shrubs.

Fossil remains of these Triassic land _____
reptiles have been found in Africa _____
Antarctica and India. _____
_____
_____

**Evidence #5: Geologic deposits-**

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Geologic deposits from southeast Brazil and southwestern Africa show great similarities until about 100 million years ago.

**Evidence #6: Rock relationships**

The following 4 regions-Antarctica, South Africa, Brazil (SA) and India all contain the same rock sequence of glacial tillites followed by shales and coal beds containing the fossils of Glossopteris.

**Evidence #7: Paleomagnetism**

North America and Europe shared the same polar orientation before they drifted apart.

**Evidence #8: Geosynclines**

Downwarping of the rock layers forming a Paleozoic geosyncline form a continuous line across southern South America and Australia.

**Part C: Analysis and Conclusions:**

- After completing Parts A and B, students should answer the questions in the **Analysis and Conclusions** section.

## *Student Activity Sheet Moving Plates, Changing Climates*

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**Student Activity Sheet #1**

- **Plate collision:** Two plates collide head on; this causes uplifting which results in mountains rising and earthquakes.

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**Part B: Evidence of Tectonic Movement:**

**Background:** The tectonic plates are not stationary. Based on scientific evidence, scientists agree that all of the continents were once joined together in a supercontinent called *Pangaea.* As a result of plate movements, the continents are in their present locations and continue to move at about 2 cm per year. The scientific evidence include fossils, landforms, rock layers, magnetic fields and glacial markings.

- Study the information under **Evidence.**
  - In the space next to each item, write the implication the evidence presents in terms of their former locations and their relationships to each other.
- Cut out the continents on the ditto sheet labeled **Part B.**
  - Move the pieces around until you achieve a location that supports the evidence.
  - Paste the continents in place on **Activity Sheet #2.**

Student Activity Sheet # 1

**Evidence #1:Glossopteris**-belonged to an extinct group of plants known as seed ferns. Although seed ferns had leaves much like the ferns of today, they produced seeds, not spores.

Fossils were found in Argentina, South Africa, India, southern Madagascar, central Antarctica, and eastern Australia; also in France, Russia and NE Siberia. _____

**Evidence #2: Glaciation** - occurred in cycles over the course of earth history beginning in about 350 M years ago;

Glacial deposits from 300 M yrs ago covered large portions of south and southeastern South America, the southern half of Africa, Madagascar India, the southern half of Australia and the bottom half of Antarctica _____

**Evidence #3: Mesosaurus fossils**- Mesosaurus was a small lizard-like animal about 20 cm long that lived in shallow freshwater environments.

Water reptiles have been found in both Brazil and Africa. _____

**Evidence #4: Lystrosaurus fossils**- Lystrosaurus was a medium sized reptile that lived on land and ate the leaves of small deciduous trees and shrubs.

Fossil remains of these Triassic land reptiles have been found in Africa Antarctica and India. _____

**Evidence #5: Geologic deposits**-

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Student Activity Sheet #1

### Evidence #6: Rock relationships

The following 4 regions-Antarctica, South Africa, Brazil (SA) and India all contain the same rock sequence of glacial tillites followed by shales and coal beds containing the fossils of Glossopteris.

### Evidence #7: Paleomagnetism

North America and Europe shared the same polar orientation before they drifted apart.

### Evidence #8: Geosynclines

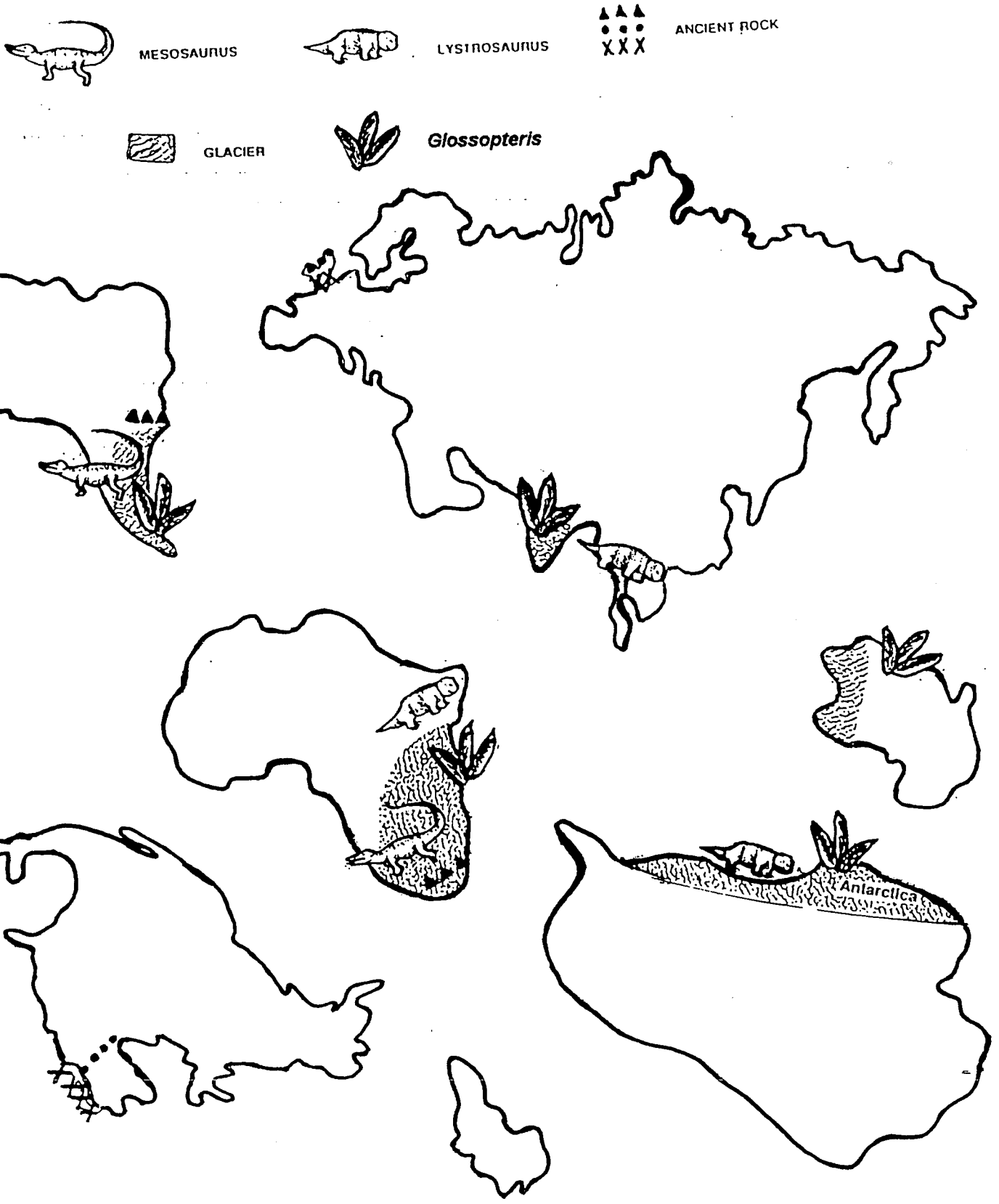
Downwarping of the rock layers forming a Paleozoic geosyncline form a continuous line across southern South America and Australia.

**Part C: Analysis and Conclusions:**

- After completing Parts A and B, answer the questions in the **Analysis and Conclusions** section.

*Student Activity Sheet #2*

PART B: Evidence of Tectonic Movement- Cut out and arrange the continent pieces below.



Student Activity Sheet #3

## Part C: Analysis and Conclusions:

1. How are weather and climate different? _____

2. What are three reasons for natural climate change? _____

3. What two major events in Earth history were caused by natural climate change? _____

4. Before scientists can predict future climatic conditions, what do they have to know?

5. What are tectonic plates? _____

6. What form of heat transfer is responsible for the movement of these plates ?

7. List the four ways that plates can interact with each other. _____

8. What pattern did you notice after plotting the earthquake locations? _____

9. Give a simple description of the "Ring of Fire". Why do you think it is called that?

10. The Hawaiian Islands are not located along a fault. What could be the reason for their development? _____

11. What pieces of evidence do scientists use to support the theory that the Earth's plates move? _____

Student Activity Sheet #3

12. What does the fossil evidence tell you about the location of South America and Africa in the past? _____

_____

13. What piece of evidence suggests that Africa was not always a tropical climate?

_____

_____

14. Glossopteris was a large fern-like plant that grew in warm wet climates. What does this tell you about the past climates of Antarctica, Africa, India , Greenland and South America? _____

_____

15. What type of evidence has been used to locate the past climates of North America and Europe? _____

16. Which of the present day continents have undergone at least 2 major shifts in climate conditions? Explain. _____

_____

_____

17. Mesosaurus fossil have been found on both South America and Africa. Short of walking on water across the ocean, how did the animals get from one place to the other? _____

_____

_____

18. When were South America and Africa probably joined? Give evidence to support your answer. _____

_____

_____

19. The fact that 4 regions that now have very different climates also share the same type of rocks as well as coal beds, suggests some radical changes in climate. Give some possibilities for this type of evidence. _____

_____

_____

_____

_____

20. Based on all the evidence presented, what conclusion can you draw about the location of the continents in the past as compared to their positions at present? _____

_____

_____

_____

21. The term *Pangaea* means "all lands". Do you think this term is an appropriate name for the ancient "supercontinent"? Why ? _____

_____

_____

_____

22. How do you know that the climate was warm when Lystrosaurus lived? Explain.

_____

_____

_____

23. What do you think happened to the polar orientation when North America and Europe moved apart?_____

_____

24. When did the Earth's climate probably enter a glacial period for the first time?

_____

_____

25. Glacial and interglacial periods are cyclical, that is they occur in cycles over long periods of time. Which continent has probably had glacial conditions over the longest period of time? Explain. _____

_____

_____

_____