

WEGENER'S PUZZLING CONTINENTS

Overview:

Although Alfred Wegener was not the first to suggest that continents have moved about the Earth, his presentation of carefully compiled evidence for continental drift inspired decades of scientific debate. Wegener's evidence, in concert with compelling evidence provided by post World War II technology, eventually led to universal acceptance of the theory of Plate Tectonics in the scientific community

Objectives:

- Students will observe and analyze scientific evidence used by Wegener.
- Students will read and interpret maps and map symbols.
- Students will use the evidence to try to reconstruct the continents.
- Students will interpret the evidence to formulate a scientific argument.

To start this activity the teacher will present background information on Wegener. Students will then be placed into groups of 2 to 3 and work to piece together continent cut-outs using this evidence. As students fit the continents together they find that isolated pieces of geologic information (for example, fossils) are no longer isolated. Groups describe what they have found, and must use evidence to construct an argument about their super-continent's shape.

For each student group:

- Student Map of the World Today
- Key to Wegener's Evidence sheet
- Student Puzzle Pieces
- Crayons or markers
- Scissors
- Glue or tape

Teacher instructions for activity:

Briefly present background on Wegener. Stress that although others had recognized the fit of Africa and South America, it was Wegener who gathered other scientific data to support his theory.

- Divide students into groups of two or three. These small groups allow students to discuss the significance of different lines of evidence as they piece together the continental puzzle.
- Each group is given a cut-out sheet containing fossil evidence (Student Puzzle Pieces), the Key to Wegener's Evidence sheet, the Student Map of the World Today reference sheet, crayons or markers, and a pair of scissors.
- Groups label the continents or land mass on each piece. The students then color each fossil type and the Key to Wegener's Evidence sheet. Then cut out the land masses from the evidence sheets.
- Have the students arrange the puzzle pieces using the Key to Wegener's Evidence to support their arrangement.
- The final puzzle configuration should be attached to paper with glue or tape.
- When finished, each group will present and defend their reconstruction
- You may compare the students' reconstructions with Wegener's Key to Continental Positions about 250 million years ago (Teacher Copy)

Hints for solving the puzzle:

- Have the students look for all the pieces with the fossil remains of Cynognathus and then put them together (South America and Africa).
- Then look for fossils that extend beyond the plate boundary such as the fern Glossopteris and the land-dwelling reptile Lystrosaurus. Put all of the continents with Glossopteris and Lystrosaurus near each other. Notice how two of the continents (Africa and Antarctica) have the end regions of Lystrosaurus. Lystrosaurus is the key to solving the puzzle. What happens to the other continent (India) if you put Antarctica next to Africa? The students must place India next to Africa to complete the puzzle.
- You can also use the Puzzle Outline Hint as a base for the puzzles.

Assessment suggestions:

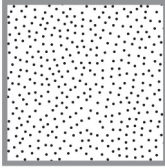
- Students evaluate Wegener's hypothesis based on the evidence they observe.
- Student groups each write a 'position statement' on what evidence they used to determine a likely shape of their super-continent. Each group then presents their conclusion as they would at a professional scientific meeting, explaining their research and how they came to this conclusion. Other students are encouraged to ask probing (but polite!) questions.
- For self-assessment, the teacher may hand out the Wegener's Key to Continental Positions.
- it is okay if students don't get the "correct" answer or the same solution Wegener proposed as long as they can explain their thought process and how they used the evidence to arrive at their conclusion. There is much information missing from the picture. For example, ancient shorelines were not the same as they are today due to changes in sea level and the tectonic process (continents colliding and pulling apart, causing rocks to be added or torn off). Scientists still debate the fine details of paleogeographic (ancient geography) reconstruction. It is far more important to have students grasp the concept of how scientists look for clues, or evidence, and put the pieces together to solve a problem.
- Students should understand that using the shape of the continents to fit them back together is using one type of evidence. Using the presence of the same type and age fossils is another. The presence of the same rock types is another form of evidence. Ask students if they can think of other types of evidence to search for that might be useful in solving their puzzle

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Directions:

1. Label the land masses on each sheet. Color the fossil areas to match the legend below.
2. Cut out each of the continents along the edge of the continental shelf (the outermost dark line). Alfred Wegener's fossil evidence for continental drift is shown on the cut-outs.
3. Try to logically piece the continents together so that they form a giant supercontinent. Use Wegener's fossil evidence to place them in the correct positions.
4. When you are satisfied with the 'fit' of the continents, glue or tape the land masses down on a piece of paper and answer the analysis questions that follow.

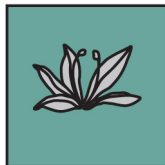
Key to Wegener's Puzzling Evidence – Fossils:



The continents are surrounded by the **continental shelf** (stippled pattern), which extends beyond the continent until there is a large change in slope.



By about 300 million years ago, a unique community of plants had evolved known as the **European flora**. Fossils of these plants are found in Europe and other areas. Color the areas with these fossils yellow.



Fossils of the fern **Glossopteris** have been found in these locations. Glossopteris had very heavy seeds that could not move by wind.

Color the areas with these fossils green.



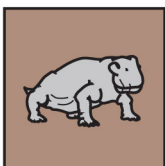
Fossil remains of the half meter-long fresh water reptile called **Mesosaurus**. Mesosaurs had limbs for swimming, but could also walk on land. Other evidence suggests that although they lived in water at times, they were not strong swimmers.

Color the areas with these fossils blue.



Fossil remains of **Cynognathus**, a land reptile approximately 3 meters long that lived during the Early Mesozoic Era, about 230 million years ago. It was a weak swimmer.

Color the areas with these fossils orange.



Fossil evidence of the Early Mesozoic, land-dwelling reptile **Lystrosaurus**. They reproduced by laying eggs on land. In addition, their anatomy suggests that these animals were probably very poor swimmers. Color the areas with these brown.

Name: _____

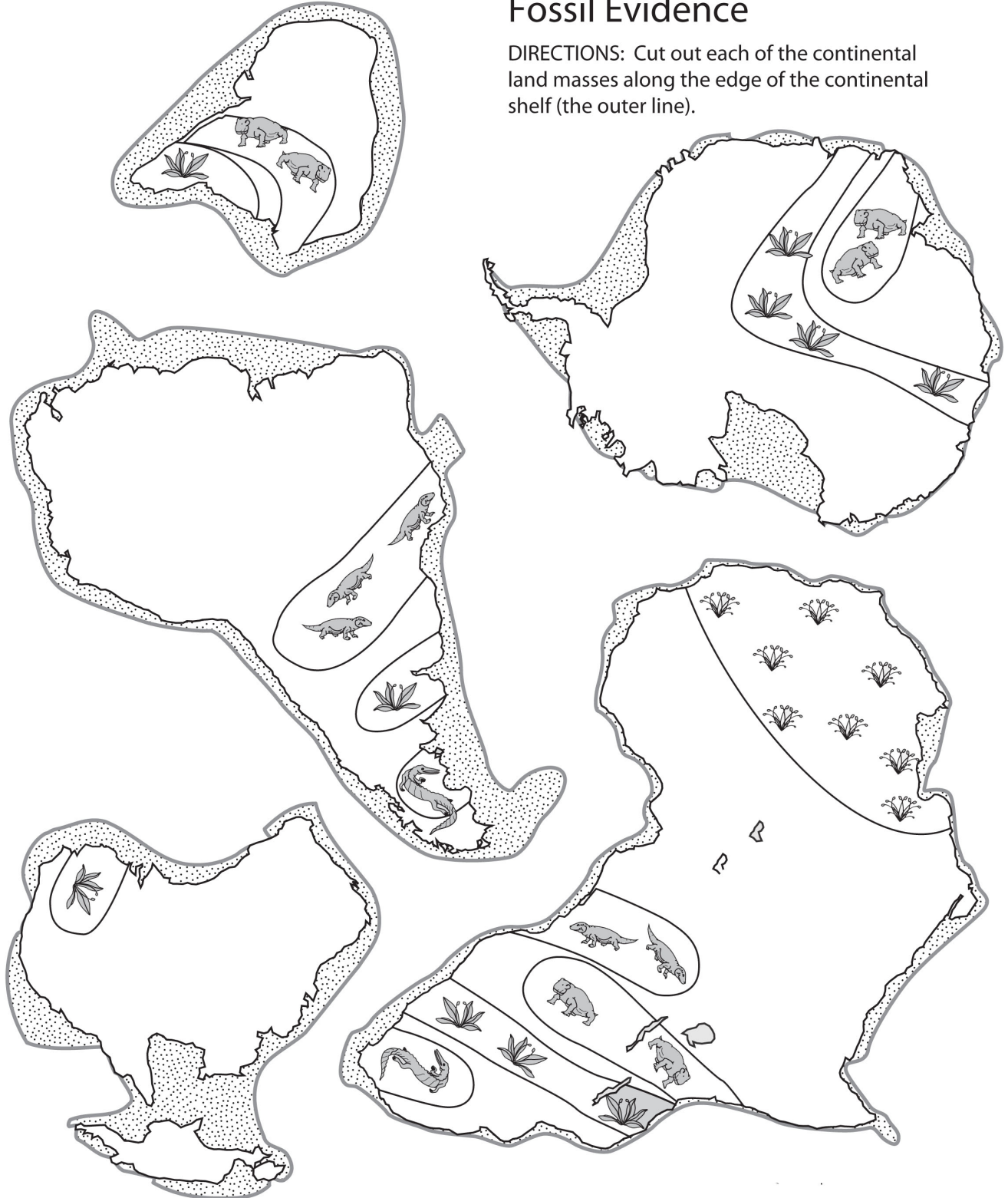
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WEGENER'S PUZZLING CONTINENTS

Fossil Evidence

DIRECTIONS: Cut out each of the continental land masses along the edge of the continental shelf (the outer line).



Name: _____

Date: _____

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Analysis Questions:

1. Imagine you are Alfred Wegener. Write a one-paragraph statement to summarize your work. Your summary must include descriptions of:
 - a. What your map shows about the Earth 225 million years ago (What does the map show?)
 - b. How the fossil evidence helped you to put the landmasses together (What was your process?)
 - c. Why the fossil evidence is good (Why do you think your map is a good one?)

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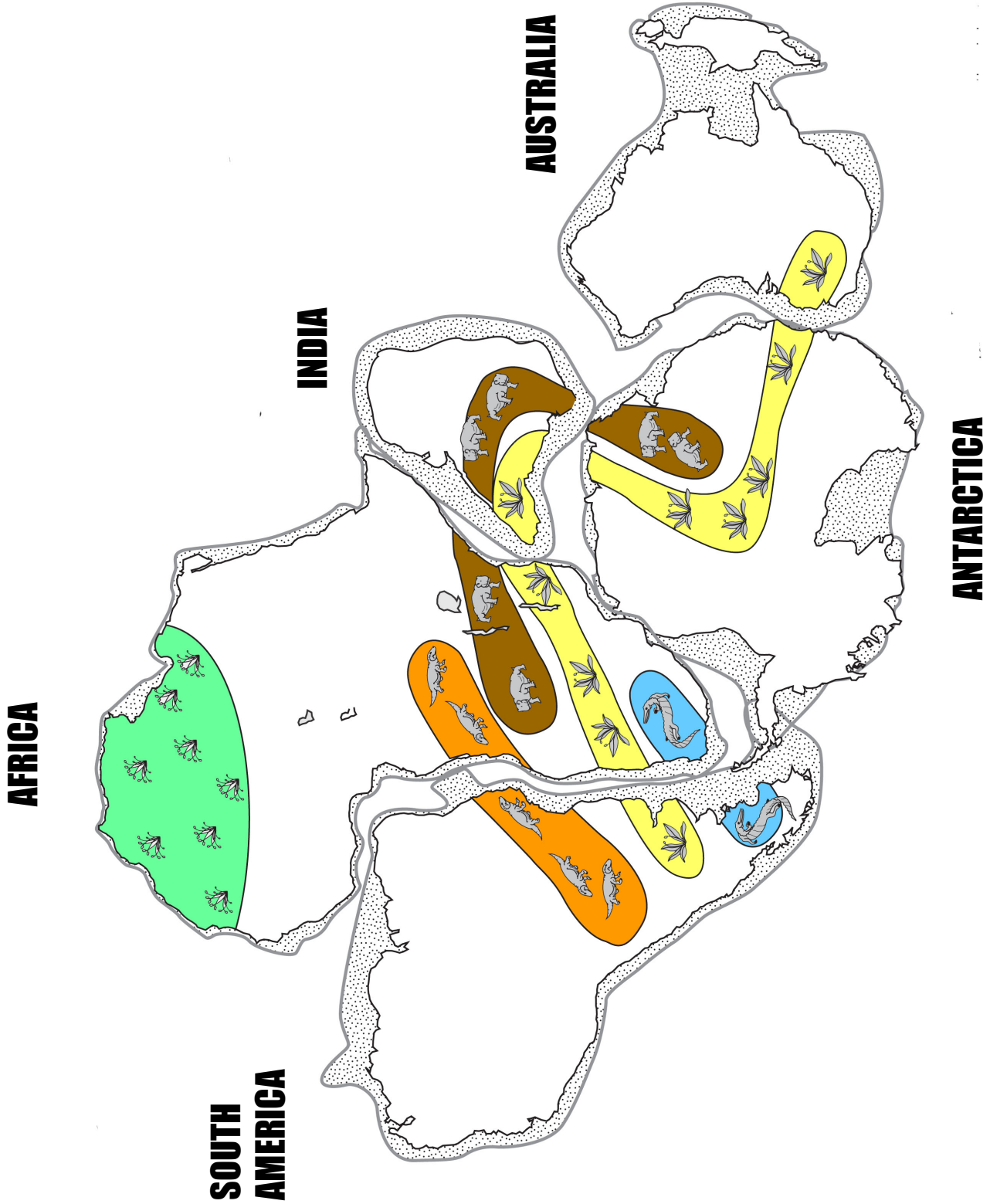
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WEGENER'S PUZZLING CONTINENTS (KEY)



TEACHER NOTES: Alfred Wegener's Story

Perhaps Alfred Wegener's greatest contribution to the scientific world was his ability to weave seemingly dissimilar, unrelated facts into a theory, which was remarkably visionary for the time. Wegener was one of the first to realize that an understanding of how the Earth works required input and knowledge from all the earth sciences.

Wegener's scientific vision sharpened in 1914 as he was recuperating in a military hospital from an injury suffered as a German soldier during World War I. While bed-ridden, he had ample time to develop an idea that had intrigued him for years. Like others before him, Wegener had been struck by the remarkable fit of the coastlines of South America and Africa. But, unlike the others, to support his theory Wegener sought out many other lines of geologic and paleontologic evidence that these two continents were once joined. During his long convalescence, Wegener was able to fully develop his ideas into the Theory of Continental Drift, detailed in a book titled *Die Entstehung der Kontinente und Ozeane* (in German, *The Origin of Continents and Oceans*) published in 1915.

Wegener obtained his doctorate in planetary astronomy in 1905 but soon became interested in meteorology; during his lifetime, he participated in several meteorologic expeditions to Greenland. Tenacious by nature, Wegener spent much of his adult life vigorously defending his theory of continental drift, which was severely attacked from the start and never gained acceptance in his lifetime. Despite overwhelming criticism from most leading geologists, who regarded him as a mere meteorologist and outsider meddling in their field, Wegener did not back down but worked even harder to strengthen his theory.

A couple of years before his death, Wegener finally achieved one of his lifetime goals: an academic position. After a long but unsuccessful search for a university position in his native Germany, he accepted a professorship at the University of Graz in Austria. Wegener's frustration and long delay in gaining a university post perhaps stemmed from his broad scientific interests. As noted by Johannes Georgi, Wegener's longtime friend and colleague, "One heard time and again that he had been turned down for a certain chair because he was interested also, and perhaps to a greater degree, in matters that lay outside its terms of reference -- as if such a man would not have been worthy of any chair in the wide realm of world science."

Ironically, shortly after achieving his academic goal, Wegener died on a meteorologic expedition to Greenland. Georgi had asked Wegener to coordinate an expedition to establish a winter weather station to study the jet stream (storm track) in the upper atmosphere. Wegener reluctantly agreed. After many delays due to severe weather, Wegener and 14 others set out for the winter station in September of 1930 with 15 sledges and 4,000 pounds of supplies. The extreme cold turned back all but one of the 13 Greenlanders, but Wegener was determined to push on to the station, where he knew the supplies were desperately needed by Georgi and the other researchers. Travelling under frigid conditions, with temperatures as low as minus 54 °C, Wegener reached the station five weeks later. Wanting to return home as soon as possible, he insisted upon starting back to the base camp the very next morning. But he never made it; his body was found the next summer.

Wegener was still an energetic, brilliant researcher when he died at the age of 50. A year before his untimely death, the fourth revised edition (1929) of his classic book was published; in this edition, he had already made the significant observation that shallower oceans were geologically younger. Had he not died in 1930, Wegener doubtless would have pounced upon the new Atlantic bathymetric data just acquired by the German research vessel *Meteor* in the late 1920s. These data showed the existence of a central valley along much of the crest of the Mid-Atlantic Ridge. Given his fertile mind, Wegener just possibly might have recognized the shallow Mid-Atlantic Ridge as a geologically young feature resulting from thermal expansion, and the central valley as a rift valley resulting from stretching of the oceanic crust. From stretched, young crust in the middle of the ocean to seafloor spreading and plate tectonics would have been short mental leaps for a big thinker like Wegener. This conjectural scenario by Dr. Peter R. Vogt (U.S. Naval Research Laboratory, Washington, D.C.), an acknowledged expert on plate tectonics, implies that "Wegener probably would have been part of the plate-tectonics revolution, if not the actual instigator, had he lived longer." In any case, many of Wegener's ideas clearly served as the catalyst and framework for the development of the theory of plate tectonics three decades later.