

PowerPoint Notes on Plate Tectonics, Geodesy, and VLBI

Slide 1: Shows and defines Plate tectonics.

Slide 2: Around 1912 Alfred Wegener first came up with the idea of plate tectonics by looking at the continents. As smaller children we might have also wondered as he did; if the continents actually fit together like a puzzle. Two examples are given, including the Brazil-African link which is what influenced Wegener.

Slide 3: According to the theory, all the continents were one, Pangaea. Over 300 million years they drifted apart to where they are now. Hit the **green** button to try to fit the continents together.

Slide 4: Tells us what Very Long Baseline Interferometry or VLBI is and how it works. A distant quasar is looked at with different telescopes. The time the telescopes receive the signal is carefully timed by an atomic maser clock, accurate to 1 second in a million years. The data is correlated to determine the distance between the telescopes. VLBI is very accurate, around 1 part per billion. Hit the **green button** to see more.

Slide 5: Another description of how VLBI works.

Slide 6: A picture of the 37 meter radio telescope at Haystack.

Slide 7: To measure the continental drift between North America and Europe, two radio telescopes were used--the one at Haystack and one in Germany.

Slide 8: VLBI provides very accurate measurements, around 1 part in a billion. We can detect millimeter changes in a distance of 6000 km. This is like being in Massachusetts and reading the date on a nickel in San Francisco, California. So even though we have an accurate measurement, do we have experimental errors and uncertainty? You betcha!

Slide 9: We always have errors, regardless of the accuracy of the measurement. How do we handle them?

Slide 10: This slide shows the uncertainty in measurement over time. Note that:

- Uncertainty is always there.
- That it decreases over time with better instrumentation and experimental design.
- From about 1995 to 2000 there doesn't seem to be much error, but that is because only a few measurements were taken.
- From 2001 to the present there still is random error which has leveled off at around 0.005 m or 5 mm.

Slide 11: After removing the outliers, a linear plot of the change in distance versus epoch or year is shown. The slope is 16.8 mm/year over a distance of around 6000 km. The R^2 value is around 0.99 indicating an outstanding fit. Notice how the data points seem to fit the line better as the uncertainty in measurement gets smaller.

Finally notice that after 1995, you can detect a fine structure in the data, it seems to oscillate around the least square line. This could never have been found when the data had more uncertainty. Lowering the uncertainty shows more fine structure.

Slide 12: A blow up of that fine structure and removing the slope does indeed show a yearly oscillating pattern. A sine function with a period of one year is mapped on it. Scientists think this is due to the slight fluctuations due to seasonal changes around the base of the telescopes (contraction due to cold in winter and expansion due to warm in the summer.)