

Exercise 9

Modified from:

Historical Earthquakes and Uplift/Subsidence of Sumatra from Coral Growth Rings -- Advanced Version

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URL: <http://serc.carleton.edu/margins/minilessons/31965.html>

Summary:

The Sumatra region is prone to earthquakes because it lies at the boundary of two of Earth's shifting tectonic plates. The Indian Ocean crust is creeping steadily northeast and subducting beneath Sumatra. The steady horizontal movements, and pulses of faster horizontal motion that occur during earthquakes, are recorded by GPS stations on the islands. But GPS has only been recording horizontal land motion since the 1980s, so it can't tell us about earthquakes that happened long ago. GPS vertical motion data are not reliable, and are lacking for underwater regions like those at subduction zones.

In order to figure out how often large earthquakes happen in the Sumatra region, scientists have turned to coral micro-atolls. They also use coral records to reconstruct progressive sea-level changes. In this lab, you will use data from real corals collected in Sumatra to track the sea-level and earthquake record of the region over the past century.

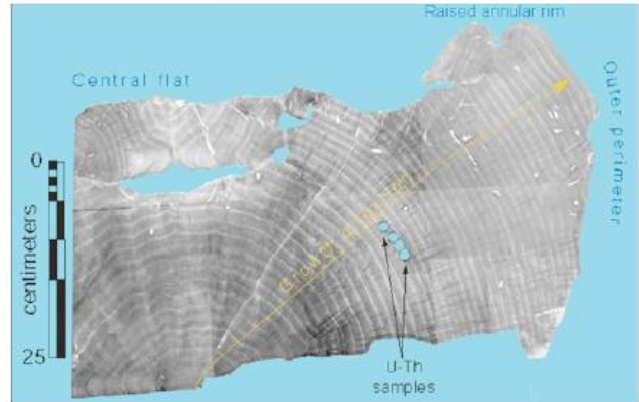
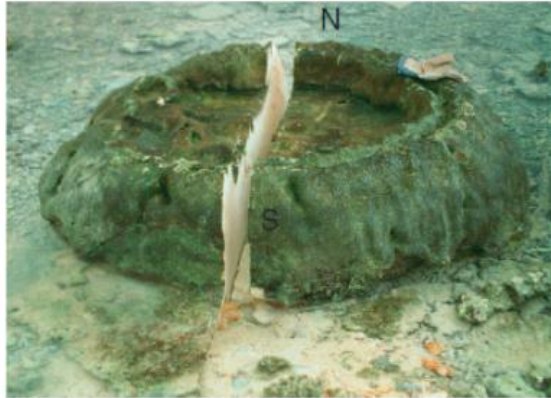
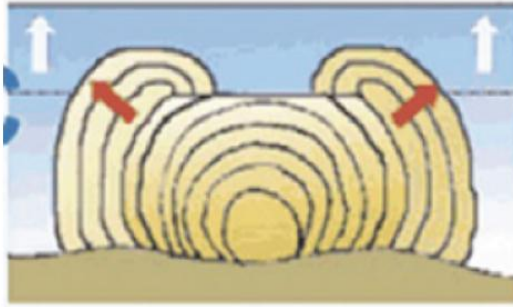
Definitions:

- 1) Atoll—a ring-shaped coral reef or a string of closely spaced small coral islands, enclosing or nearly enclosing a shallow lagoon. Coral heads from Sumatra are considered “microatolls” because each head is a small, circular “island.” (The outer ring is alive but the inner area is submerged and inactive.) Refer to this website <http://www.tectonics.caltech.edu/outreach/highlights/sumatra/coral.html> for more explanation.
- 2) Coseismic—the time of the earthquake. Period: instantaneous, seconds to minutes
- 3) Interseismic—time between earthquakes. Period: years to thousands of years
- 4) Unconformity (general definition)—missing time in the geologic record

Objectives

When studying earthquakes, scientists often concentrate on coseismic displacement of land along faults. In recent years, we have learned that there are also interseismic land level shifts in earthquake-prone regions. In this assignment, you will use coral microatolls to measure both coseismic and interseismic land-level changes. You will learn that corals provide precise data on

- 1) how land level changes
- 2) when a historic earthquake happened



Data Analysis

- 1) The upper part of the attached figure is a vertical cross section through a coral microatoll from Bai area in Sumatra. The cross section shows how the coral grew by adding a band each year, expanding outwards over time from right to left in the sketch. Each two-digit number indicates the year that band grew (all years in the 20th century). The last one grew in 1997, the year the slab was cut. The outer edge is the living part of the coral.
 - a. Using the scale bar, estimate the growth rate of the coral (measure the distance between several bands and give the average).
 - b. What does the top of each growth ring (HLS = "highest level of survival") represent in terms of water/tidal level?
 - c. Make a list of HLS over time, starting in 1964. (Use the scale at the left of the sketch.)

Then plot your data on the graph below the coral cross section OR on a computer graphing program of your choice.

NOTE: some bands are incomplete, so you will need to exercise your scientific judgment to either trace these lines to completion, or eliminate them from your analysis.
- 2) Based on your understanding of an unconformity, do you agree that there are unconformities in the coral record as well? Use the following figure to guide your understanding of coral growth-ring unconformities.

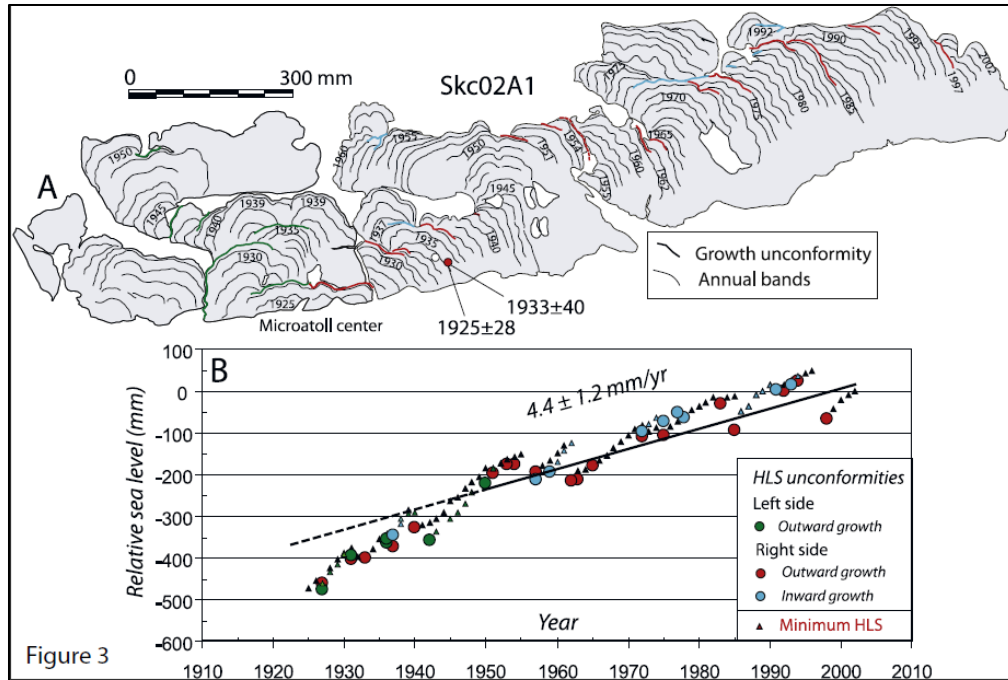


Figure 3

- What does an unconformity look like in the coral cross section?
- What does an unconformity represent in the growth pattern of a coral?
- To familiarize yourself with coral unconformities, on the coral sketch of Figure 2, mark each clear unconformity with a color (they are already indicated with a bolder line).
- For what time period (give the years) is the record incomplete because of erosion? How can you tell?

Interpretation

Use your plots and the sketches of the coral slabs to answer the following questions:

- From 1964–1997, has this coral been emerging, submerging, or both? How can you tell?
- Calculate the coral's average rate of movement during each emergence and/or submergence period over the 40 years that you graphed.
- During this period, global sea level has been rising by about 2 mm/y. Use this record to correct the answer to determine the site's actual average tectonic uplift or subsidence rate.
- Do you think your result indicates coseismic or interseismic motion? Why?
- Is there an unconformity every year? Why or why not?

Head Bai

