**Sea Level Change and Historical Earthquakes of Sumatra from Coral Growth Rings—Advanced Version**

**Solution Set**

Part I

1. Atoll: a ring-shaped coral reef or a string of closely spaced small coral islands, enclosing or nearly enclosing a shallow lagoon.
2. Hemispherical corals grow radially outward, building annual calcium carbonate bands similar to tree rings. The coral genus *Porites* provide the best sea-level and paleoseismic records. However, there are several species of *Porites* that do not grow hemispherically and would not serve as a sea-level record. Also, *Porites* can grow in places that don’t have earthquakes; there they can still serve as sea-level markers.
3. Coseismic: The time of the earthquake, lasting seconds to minutes.
4. Interseismic: the time between earthquakes, lasting years to thousands of years.
5. Unconformity: a period of time that has no representation in the geologic stratigraphy, due to non-deposition and/or erosion. It indicates *missing* time.

Part II

1. The radial growth rate is 9-11 mm/yr (or ~1 cm/yr).
2. Coral HLS represents low-tide level.

2) Yes, there are “unconformities” in the coral record, where parts have been eroded.

a) Coral unconformities form when an older surface erodes. Also, younger bands can curl over and grow inward; their upper parts are no longer parallel to older bands.

b) A coral unconformity represents death of part of the coral growth surface and regrowth around it.

c) See bold lines in Fig. 2.

d) The coral surface is uneven and not parallel to annual banding, indicating erosion, in the years 1962–72.

3)

4)

Part III

1)

a) Head Bai submerged from 1963–1974 and emerged from 1974–1997. During submergence, each HLS unconformity is higher than the previous one; during emergence, each HLS unconformity is lower than the previous one. Also the graph reflects both events.

b) Submergence was 0.5 cm/yr from 1964–1974, and emergence was ~0.6 cm/yr.

c) The rate of uplift was ~8 mm/yr (6 mm/yr + 2 mm/yr)

d) Both submergence and emergence must be interseismic, since they occurred gradually over many decades. However, the change between the two may be coseismic. Pretty abrupt change.

e) There isn’t an unconformity every year, because the annual extreme low tide varies from year to year. Unconformities only occur when the HLS drops lower than the highest level of growth of the coral surface in the previous year.

2)

a) Head Tb1 has been submerging.

b) The average rate of submergence is 5.8 mm/yr. The rate seems to have been fairly constant without sudden jumps in HLS.

c) The tectonic subsidence rate is 3.8 mm/yr.

d) The subsidence rate appears to have slowed after 1970. A coseismic event might have triggered this change. However, the subsidence must still be interseismic, since it occurs gradually over many decades.

3)

a) Head Tb2 submerged at 7.1 mm/yr between 1900 and 1935.

b) The tectonic subsidence rate was 5.1 mm/yr.

c) There is no more than 3 cm of difference between uneroded coeval HLS levels between the two sides. Eroded coeval HLS levels differ by up to 5 cm on this coral head.

4)

a) During 1960-2000, Bai uplifted 4.4 mm/yr while Bendera subsided 2.0 mm/yr.

b) Sites close to the trench subside interseismically while those farther away uplift.

5)

a) Bendera uplifted 88 ± 5 cm during the 1935 earthquake (5 cm uncertainty is reasonable since the top of Tb2 is slightly eroded, and Tb1 has only a minimum HLS in 1935).

b) The tectonic subsidence rate at Bendera decreased by 1.3 mm/yr after the 1935 earthquake. This illustrates that coseismic events can cause changes in interseismic deformation rates.

NB: Differences as great as 0.5 mm/yr from the stated rates in this solution set should be expected from students and accepted as correct.