

General Oceanography  
Geology 105  
Expedition 10 - Tsunami  
Complete by Saturday at 11:00 PM

Name \_\_\_\_\_

### Expedition Objectives

- Learn about the scientific investigations into past great earthquakes of magnitude 9 (M=9) or greater along the Cascadia subduction zone off northernmost California, Oregon and Washington, and the potential for a future devastating event on the same scale as the 2004 Indian Ocean earthquake and tsunami, which resulted in the loss of more than 230,000 lives.
- **Homework** - post one multiple choice question one of the methods of scientific investigation used by Brian Atwater to identify the M=9 earthquake in and a second multiple-choice question on an investigation carried out by one of the other scientists in this expedition in your Expedition 10 Learning Group Discussion in Canvas,

We will first several segments a 50 minute-long video from the BBC, the *Next Megaquake*, produced in 2006, and available in YouTube.

A transcript of the program can be access at [http://www.bbc.co.uk/sn/tvradio/programmes/horizon/megaquake\\_prog\\_summary.shtml](http://www.bbc.co.uk/sn/tvradio/programmes/horizon/megaquake_prog_summary.shtml) if you need it.

After the BBC we will two segments of the NOVA program, *Deadliest Earthquakes*, one 3 minutes-long and another 8 minutes-long, on the recent scientific studies on understanding the frequency of great earthquakes along the Cascadia subduction zone, using sediment samples from the deep-sea and measurements of tiny, nearly imperceptible "slow-slip" earthquake that may foretell a great earthquake?

### Part I. Watch *The Next Megaquake* (called *Cascadian Megaquake 1 of 5* on YouTube):

**Segment 1 - 10 minutes long at <http://youtu.be/NP8cDXsvH8A>**

1. What type of earthquake fault produces the largest earthquakes on earth (00:25)?
2. Where might a great earthquake, similar to the 2004 Indian Ocean/Indonesia earthquake, strike the United States, close to California, and which cities are at risk ? (01:30)

3. What tectonic process operates along the plate boundary beneath the coast of northernmost California, Oregon and Washington that can cause a great earthquake ( $M > 8$ )? (02:30)
  
4. Describe the crustal deformation in the upper plate along a subduction zone that precedes a great earthquake? (03:35)
  
5. What oceanic process results from the rebound of the upper plate along a subduction zone during a great earthquake? (04:35)
  
6. How is a tsunami different than a wind-driven wave on the surface of the ocean and how does this relate to the threat posed to coastal populations? (05:15)
  
7. Where is the Cascadia subduction zone located and what is the length of the megathrust fault? (06:15)
  
8. How is the seismic activity along Cascadia subduction zone different from many other subduction zones worldwide and how did scientists mistakenly interpret this characteristic early on? (06:40)
  
9. What intriguing evidence first caused scientists, like Brian Atwater, to challenge the prevailing idea, at the time, of the potential for a great earthquake in this region? (08:15)



17. What is the final piece of evidence that linked all of the previous observations, both in Japan and along the coast of the Pacific Northwest, into a coherent theory? (08:00)

18. What data provided evidence for the simultaneous death of the trees (8:15)?

19. What was the date, year and time of the Cascadia earthquake? (8:40)

20. What were the effects that followed this great earthquake? (09:00)

21. Will the earthquake in 1700 happen again? (09:25)

**Segment 3 - View the first 6 minutes of the 10 minutes-long video at:**

<http://youtu.be/3SofGBUfEyw>

22. How does the length of fault rupture compare to the size and energy released by earthquakes? (00:05)

23. How does the length of the fault that ruptured during the 2004 (M=9.3) Indian Ocean earthquake compare to that estimated for the Cascadia earthquake in 1700? (00:15)

24. Why will Vancouver, Seattle and Portland be largely spared from the most powerful aspects of the tsunami but not the vacationers along the coast? (03:00)

25. Why will the cities of Vancouver, Seattle and Portland experience severe damage from the earthquake? (04:00)

**Stop at 6:00 minute mark and move on to next segment**

**Segment 4 - 10 minutes-long at <http://youtu.be/axHrvAxroUI>**

26. How do geologists, working in sediments along the coastline, learn about historical frequency of earthquakes in the past? (00:30)

27. Based on these analyses, when might the next great earthquake occur along the Cascadia subduction zone? (01:30)

28. What can we do to limit the damage of the next great earthquake and loss of life? (02:10)

29. How will countries around the Pacific Rim get a warning of the coming tsunami? (04:25)

30. Why is the tsunami predicted to have a devastating effect on the shores of the Pacific Northwest and maybe somewhat less so in Hawaii, Japan and even southern California? (05:05)

32. How should people react, if in a building, when the severe ground shaking begins?

**Segment 5 - 5 minutes-long at <http://youtu.be/W-ANmIaVMUk>**

**Fast forward to the 2 minute 40 second mark**

31. If the tsunami warning system is relatively ineffective along the coast of the Pacific Northwest, what then should people on the coast do if the ground shakes violently? (04:00)
  
32. What happens to the speed and height of the tsunami as it approaches the coastline? (04:10)
  
33. How long do the high waters of the tsunami cover the coastal areas? (04:40)
  
34. What is the best way for people in coastal regions to prepare now, prior to the eventual tsunami?
  
35. What is the lesson of the 2004 Indonesian or Indian Ocean earthquake for inhabitants of western North America?

This is end of the MegaQuake program.

***Part II. Watch two segments of NOVA program "Deadliest Earthquakes" on the Chile and Cascadia megathrusts at:***

**<http://youtu.be/I9LDXRcaWpw>**

**Immediately fast forward player to the 04:30 time mark**

36. What is the evidence for 8 feet of uplift of the crust that generated a massive tsunami related to the 2010 Chile earthquake? (06:20)
37. How do scientists measure the 30 foot height of the Chile tsunami onland? (09:30)
38. Why do tsunamis cause such incredible damage to buildings and infrastructure onland? (11:30)
39. What type of data is Chris Goldfinger using to study the history of Cascadia megathrust earthquakes and how are these data acquired, and over what period of time? (12:30)

**Move on to watch the first 9 minutes of the next segment of the program at:**

<http://youtu.be/o4n3drwryg0>

40. Describe the nature of the scientific analysis of the core samples being carried out by Chris Goldfinger and what is he trying to identify? (00:00)
41. What is the principal conclusion of this research and it's implications for the probability of future great earthquakes along the Cascadia megathrust?

42. At Cannon, how long will it take the first tsunami to arrive after the ground shaking of the Cascadia megathrust earthquake? (02:55)

43. What is Ken Creager attempting to measure and how? (04:20)

44. What does Ken Creager mean by the statement "one person's noise is another person's signal" and does this apply to the advancement of scientific knowledge over time?

45. What is the hypothesis or question that Ken Creager is testing with his research?

46. What is the potential implication of this research?

**Stop at the 9:00 minute mark of this segment**



**Part III - Brief Review of Tsunamis and Warning Systems**

47. Review *Anatomy of a Tsunami* animation (2 minutes-long) at:

<http://www.youtube.com/watch?v=StdqGoezNrY>

48. View NOAA Tsunami Forecasting (3 minutes-long)

<http://youtu.be/SiDBblWPbMQ>

49. Deploy the New Generation of DART at (1 minute-long):

- <http://youtu.be/4AoEUlcfdoY>

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**Optional, but Amazing Videos Below**

50. Tsunami Coming Ashore Devours Building at:

<http://youtu.be/IAa8BmuPqh8> - Fast Forward to 4 minute mark and watch for 3 minutes, until 7 minute 20 second mark)

51. Tsunami from Inside the Car

<http://youtu.be/QAwBvBxIOUA> (4.5 minutes):

52. The Speed of a Tsunami Onland (Yes, it is snowing) and the Aftermath at:

<http://youtu.be/V2taJExhV6g> (4 minutes and 23 seconds) :