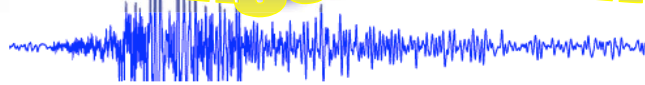


# Challenge Worksheet



Geophysics of Earthquakes

## Lab 9: Tsunamis

**Your Mission:** 1) Create a Tsunami in a box! Measure its velocity.  
2) Analyze tsunami hazards and past tsunami data

### Your Supplies:

- Plastic tub (outside)
- Sand and water (outside)
- Board with handle
- Meter stick
- Stopwatch(es)
- Tape
- Marker

### Part 1: Tsunami in a Box

### Procedure:

1. Go outside with your group and find a plastic tub.
2. Measure the length of the tub from the deepest point to the point where the water ends. Write this distance on a piece of tape and tape it on the inside wall of the tub right above the water line. You will be using this as a marker for timing the arrival of the tsunami wave.

Length of the tub = \_\_\_\_\_ m

3. Measure the depth of the water at its deepest point.

Depth of the tub =  $d_w$  = \_\_\_\_\_ m

4. Now use whatever materials you can find and build a city by the ocean. Have fun! Make a high-rise, a house on a cliff, a pier, make roads and dunes with your hands. The idea is to see how the landscape will change as a result of the tsunami.
5. Now you will simulate a wind-generated wave by blowing at the water in your tub (or any other way you can think of to simulate a large gust of wind!). Think about how fast the wave traveled. Could you possibly measure this speed? If so, what was the speed?

Record your observations here:

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6. Now you will prepare for the arrival of an earthquake and corresponding tsunami. Assign one person to be the “earthquake” – the person who will create the tsunami with the board-with-handle. In addition, assign 1 person to time the speed of the wave and another person to record. For groups of 4, have two people time the wave speed and compare results. Read the following instructions and record your times on the following page.
7. Now an earthquake will be simulated. The earthquake person will lower the board-with-handle into the water VERY slowly, as not to create any large waves. Be sure to place the board as far down and as far back as possible.

On the count of THREE the earthquake person will pull the wood up as level and as rapidly as possible by the handle. At the same time, the timers will start their stopwatches. The timers will stop their stopwatches when the wave front reaches the tape mark on the side of the tub.



## Part 2: Tsunami Hazard Analysis

### Procedure:

1. From Part 1 you saw that the tsunami wave had a much different velocity and period than wind driven waves; tsunamis have long periods and wavelengths in comparison. We can calculate the velocity of a hypothetical tsunami wave in the Pacific Ocean if an earthquake of the correct kind occurred in Chile using the following equation:

$$v = \sqrt{g * d_w}$$

where  $g$  is the acceleration of gravity and  $d_w$  is the depth of the ocean.

**Challenge Question:** What kind of earthquake (type and size) would be necessary to create a tsunami off the coast of Chile? \_\_\_\_\_

2. To obtain the depth of the Pacific Ocean, you will need to use an online resource. Login to a computer and use the website <http://jules.unavco.org/VoyagerJr/Earth> to determine the average depth of the Pacific ocean (Hint: try using the Color Topography map.)

**Average depth of Pacific Ocean:** \_\_\_\_\_ m

What would be the velocity of a tsunami in the Pacific Ocean generated by an earthquake in Chile?

**Chilean tsunami velocity:** \_\_\_\_\_

**Challenge Question:** How long would that wave take (time) to reach San Diego? To answer this question, you will need to know the velocity of the wave (above) and the distance the wave traveled. To estimate distance, figure out how many degrees latitude the wave would travel from Chile to San Diego and use the following degrees latitude-to-km conversion to get the distance:

$$1^{\circ} \text{ latitude} = 111.19 \text{ km}$$

**Time lapse to San Diego:** \_\_\_\_\_ **(don't forget units!)**

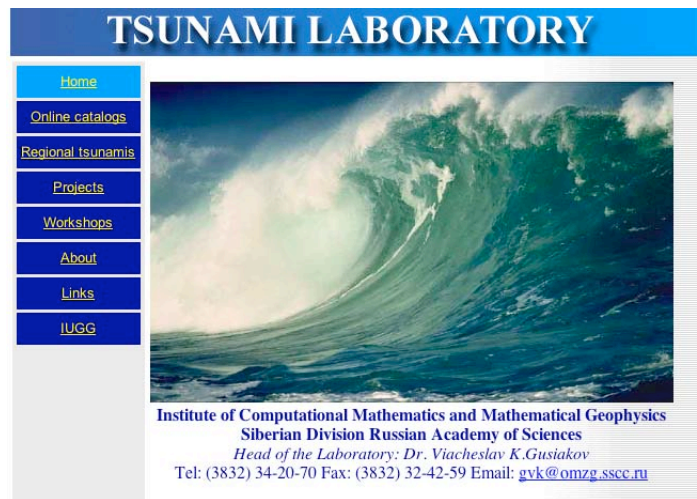
3. Now go back to the data you collected from Part 1. Given the velocity of a tsunami wave equation and the depth of the water that you measured in your box, what speed would you predict that you would measure in the tsunami in a box experiment?

**Predicted velocity:** \_\_\_\_\_

**Challenge Question:** Why is your measurement slower? (Hint: It is not just due to human reaction. Remember that the tsunami equation holds for open ocean tsunami speeds). \_\_\_\_\_

\_\_\_\_\_

4. Now go to the following website [http://tsun.sccc.ru/tsun\\_hp.htm](http://tsun.sccc.ru/tsun_hp.htm). The webpage should look something like this:



- Click on **Online catalogs**
- Choose the **On-line Pacific Tsunami Catalog, 47 B.C. to present**
- Click **Continue**
- Choose **Event data**

5. Now you will search for 4 tsunamis that caused the most **damage** and most **fatalities**.  
Click on the following selections:

<a href="#">Area</a>	<a href="#">Date</a>	<a href="#">Depth</a>
<a href="#">Magnitude</a>	<a href="#">Intensity</a>	<a href="#">Hmax</a>
<a href="#">Nobs</a>	<a href="#">Damage</a>	<a href="#">Fatalities</a>
<a href="#">Cause</a>	<a href="#">Validity</a>	<a href="#">TR</a>
<a href="#">BR</a>	<a href="#">Source region</a>	
<a href="#">Sorted by</a>	<a href="#">Legend</a>	<a href="#">References</a>

Check a damage code box you want to search for and click "OK"

☐ Nondamaging event

☐ Slight damage

☐ Moderate damage

☒ Large (severe) damage

\*\*\*Note: You must always hit **Ok** in the Select window and **Search** in the Search window to get the program to perform the next step.\*\*\*

Once the table comes up, it will have a list with ~ 107 earthquakes. You can narrow down this list by choosing a new parameter to search by. Choose **Fatalities** and enter the following numbers.

**Fatalities**

Type the new boundary values for the number of fatalities you want to search for and click "OK"

From: To:

Fatalities:

Click ok and Search. You can also sort the list by choosing **Sorted By** and **F (Fatalities)**

Select a sorting mode and click "OK"

☐ Date ☐ Depth ☐ Ms ☐ Mw ☐ Mt

☐ Int ☐ Hmax ☐ Nobs ☐ V ☒ F

☐ Ascending ☒ Descending

Write the locations of the 4 most devastating tsunamis in the Pacific here:

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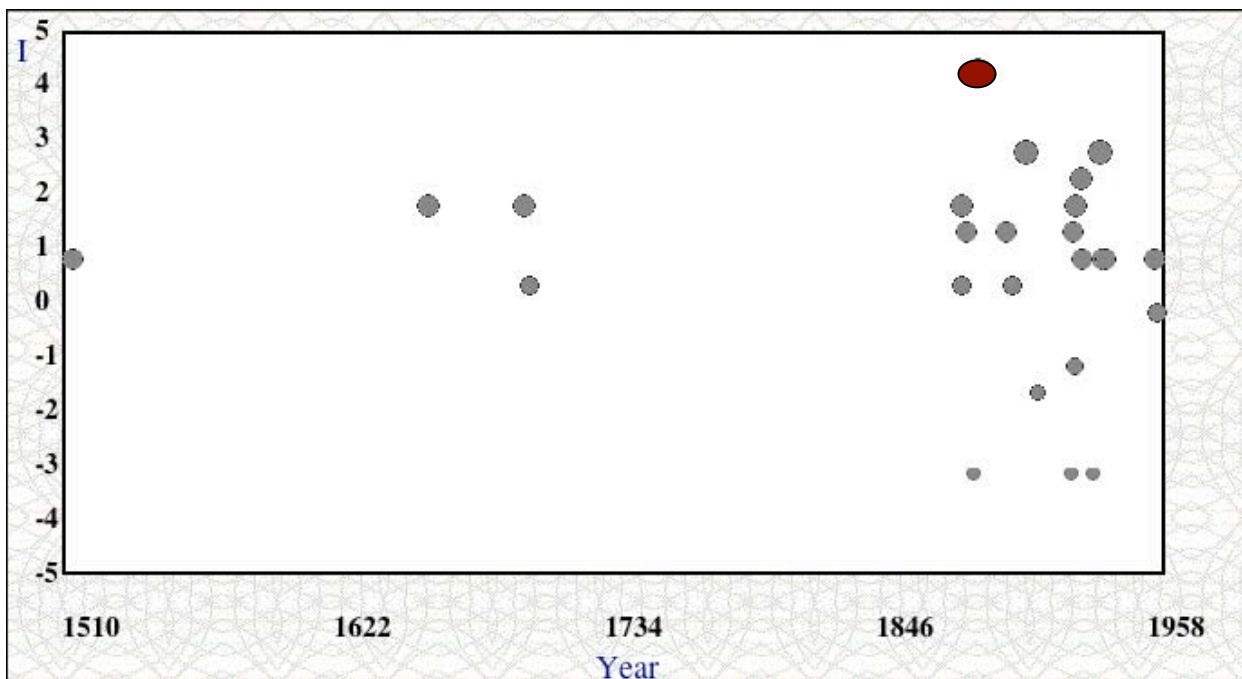
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Were they all caused by the same thing? (Hint: Use the **legend** to determine what the C stands for.) \_\_\_\_\_

6. Using the skills you practiced above, try to interpret the following plot. What earthquake is represented by the colored red dot? (Hint: Try searching by date and sorting by something else. Think about what the “I” in the y-axis column might represent from the options in the tsunami database.)





**Tsunami Event:** \_\_\_\_\_

**What was it caused by?** \_\_\_\_\_

**Now perform a web search on this event name to provide a more complete description of the event (3 sentences):**

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