Name ______________________________ Class ________________ Date ______________

Visualizing Data Relationships Between Earthquakes, Volcanoes, and Plate Boundaries in the Western United States

Student worksheet

Overview: How do we know there are different tectonic plates? What direction(s) are the plates moving? How are earthquakes and volcanoes involved? In this activity you will use web-based mapping tool, GPS Velocity Viewer, to explore earthquakes and volcanoes and study the motion of Earth's crust in the Western United States.

Part 1: Prepare your map for study

Open the UNAVCO GPS Velocity Viewer in a web browser.

- Do a web search for UNAVCO Velocity Viewer. Or, on UNAVCO's website **www.unavco.org.**, Click on Education → Education Resources → Interactive Tools → GPS Velocity Viewer
- Uncheck the box labeled **Display vectors**
- Click the **Draw Map** button. In a few seconds, the map will reload.
- Move the map to show California, Oregon, and Washington states.

Part 2: Study & Record the earthquake and volcano data

1. Half of the class will study earthquakes and the other half will study the volcanos
2. Get together with classmates who are studying the same data to become an expert on that topic. Based on your teacher's instructions, add the earthquake or volcano data to your map.

    - To display the earthquakes
        - Click on **Display volcanic centers,**
        - Select "**Show all**" under **How many markers displayed**
        - Click on **Draw Map.**
    - To display the earthquakes
        - Click on **Display Earthquakes** and
        - Select "**Show half**" under **How many markers displayed**
        - Click on **Draw Map.**
        -

3. Record your data on the map of Alaska below.

    - Draw on your map the locations of volcanos or where clusters of earthquakes have occurred.
    - Zoom in to view more detail and out to see the big picture.
    - Make a key for your map similar to those you see on the legend, such as the depth of the past earthquakes.

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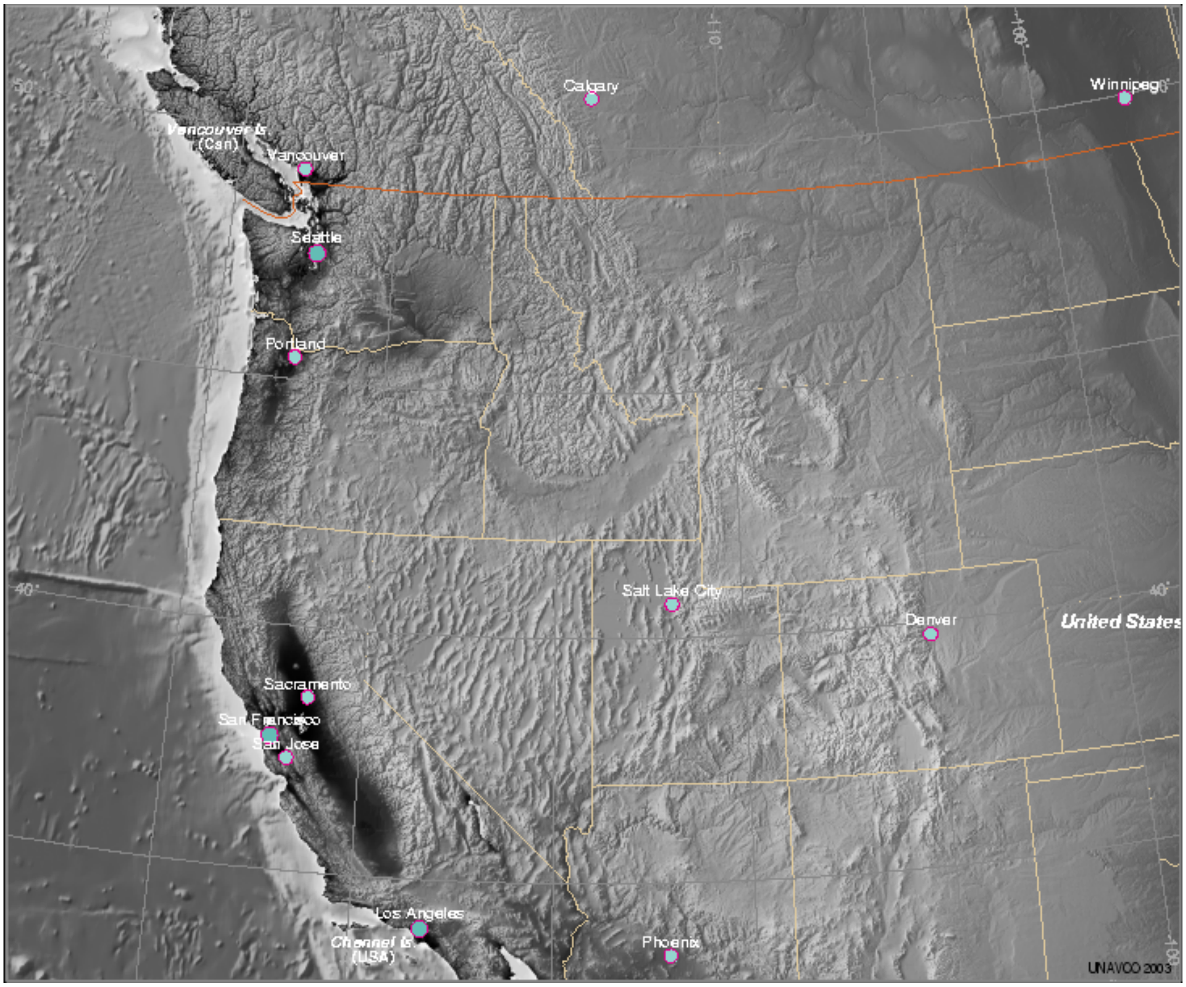

3. Discuss the questions relevant to your team's data

Earthquake data:	***Volcano Data***
How are earthquakes distributed? Where are there no earthquakes? Are they: near the edges of the continents, mid-continent, in the ocean?	How are volcanoes distributed? Where are there no volcanoes? Are they located: near the edges of the continents, mid-continent, in the ocean?
If there is a pattern, how would you describe it? Are there multiple patterns?	If there is a pattern, how would you describe it? Are there multiple patterns?
At what depth(s) do the earthquakes occur? (hint: look at the legend)?	
What other data would help you with your analysis?	What other data would help you with your analysis?

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4. Compare the Earthquake and Volcano Data Together
Get together with someone from the other data team and compare your findings. Sketch on your map the locations of the earthquakes and volcanoes from your partner's map. Discuss these questions:

A. What geographic features (mountains, plains, valleys, islands etc) are frequently found where there are only: Earthquakes? Volcanoes?

B. In which regions do you find earthquakes and volcanoes near each other? Describe the geographic features of these regions.

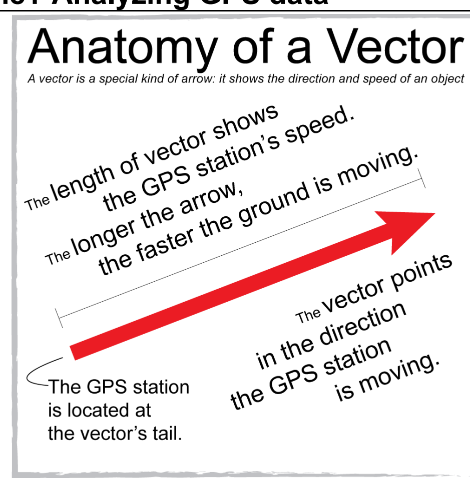
C. Summarize the relationships you discovered. Are the features you looked at (earthquakes and volcanoes) more commonly found together or separate?

D. What explanation(s) can you provide for the observed relationships?

Part 3: How is the Western US moving & deforming over time? Analyzing GPS data

About velocity vectors

A vector is a kind of arrow that shows the direction and speed of an object. In this case, GPS stations are anchored into rock or deep into soil so we can see how the whole area is moving. If the GPS stations are moving, then the ground is moving.



Each vector arrow originates at a GPS station, and points in the direction that the station is moving. Its length is proportional to the station's speed (velocity). The longer the arrow, the faster the GPS and ground is moving.

About reference frames

Every tectonic plate on Earth is in motion. Scientists compare the motion of one tectonic plate or region relative to another tectonic plate. In this activity, the vectors displayed on these maps are in the North American Reference Frame - the interior region of North America, such as central Canada and Kansas is not moving.

Reference frames allow scientists to more easily view the differences in motions on the North American tectonic plate and other adjoining plates, such as the Pacific plate. Sometimes you see surprising and subtle features. For instance, by using the North American reference frame, we can see that the very edge of the North American plate in California, Oregon, Washington, and Alaska is moving.

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Under **GNSS velocity vectors**

1. Click on the box next to: **Display vectors**
2. *2.* Under How many markers displayed select ***Show one in ten.**.*
3. *3.* Select '**Draw Map**' to update the map.

4. *Study the map and sketch* some of the vector arrows on your map:

- o Show the scale bar for the vectors on your map.
- o Zoom in and out to see more details. Pay special attention to what direction the arrows are pointing (e.g. the direction the ground is moving) and the lengths of the vector arrow (velocity).
- o Add and remove different data types (earthquakes, volcanoes, faults)

5. Discuss these questions with your teammate and come to a consensus on the answers.

- What do you notice about the length of the vectors (the velocities) from the coast to inland? What patterns do you see?
- How do the directions of the GPS vectors change?
- What patterns do you see in different regions?
- How does the velocity and direction of the GPS stations change from the coast to inland? What other areas have differing velocities or velocities? ? What about differing directions?
- What do you think is happening in these regions to cause these differences?
- How do the ground motions compare to the locations of earthquakes and volcanoes?

6. Based on the data you have, sketch where locations of the plate boundaries. (Make a legend to describe the colors.)

- Display the plate boundaries using the Viewer - how close do these match the boundaries you drew? Were there any boundaries you didn't draw? What additional information would you have needed for you to be able to draw the other boundaries accurately?
- How would you characterize the width of the plate boundaries on your map? How do they change width? Based on your data, which plate boundaries should be shown as a line or a broad zone? Why?

Wrap up: Societal Impacts

In locations with many earthquakes, volcanoes, or large changes in vector velocities or directions, what are some of the impacts to life and society?