Assignment Two - Earthquake Plotting

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Statement of Problem One

The following figures show the relationship between the distribution of earthquakes in the coastal region of the Pacific Northwest and Chile. Because both regions are subduction zones, both regions may show a correlation between earthquake and tectonic activity.

Methods

Using ggplot make a graph, let x is longitude and y is latitude, plotting magnitude on the graph of latitude vs longitude, and longitude and depth. I retrieved the data from USGS website and the data for the Pacific Northwest, we selected latitude 41 to 51, longitude -129 to - 116, and the date is from January 1st to December 31st. I chose the data from Chile in the same time period as the Pacific Northwest, the latitude is from -60 to 0, and the longitude is from -81 to -62. Download all relevant data from USGS.

Results

From Figure one, we can see that the plot of the Washington state area is quite dense, forming a sharp contrast with the Oregon state below. The plot from the depth and magnitude type shows that because Washington State is above Cascadia subduction zone, earthquakes are densely located around this area.

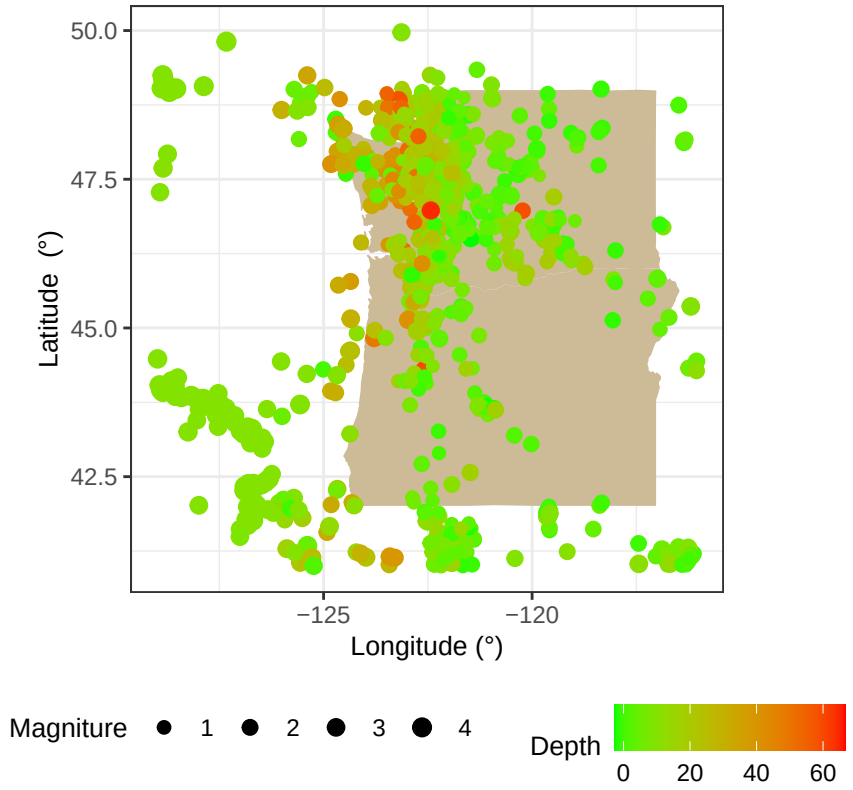

Figure One: Spatial Distribution of Earthquakes in the Pacific Northwest

It can be seen from Figure two that when the magnitude is less than 4 are filtered out. Strong earthquakes occurred near the coast at a depth of about 10 km, but one above the Cascadia subduction zone were deeper than 30 km.

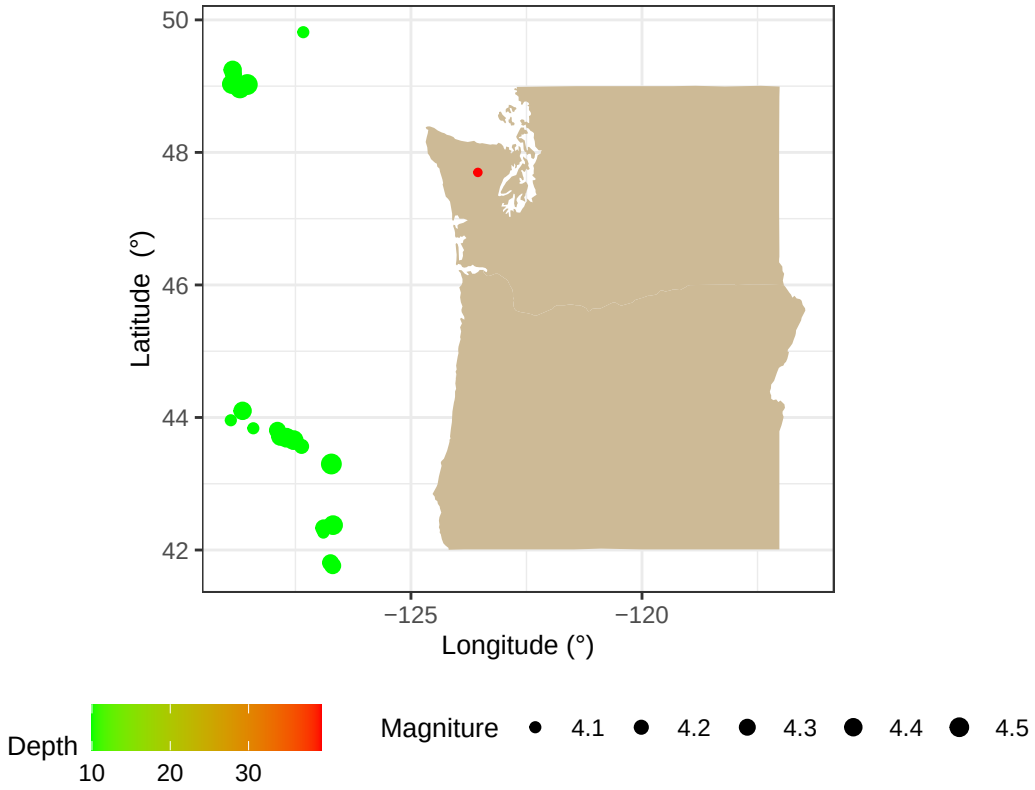

Figure Two: More Intense Earthquake

The straight line in Figure three is depth at 10 km which means it is inside oceanic crust. The longitude in this line is in the pacific ocean. What is all due to active tectonics all the Cascadia. In Figure Three, we can see most of plots concentrate at depth from 0 to 30 km. It can show earthquakes are close to the surface.

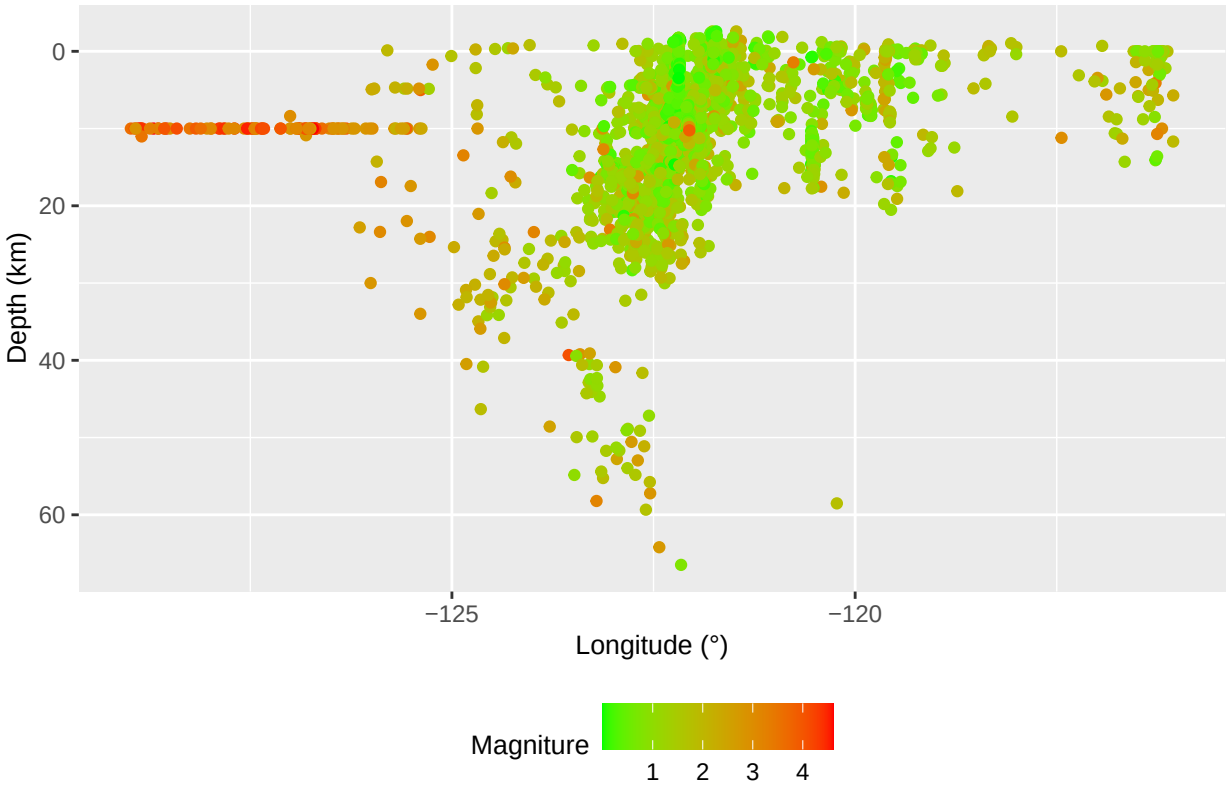

Figure Three: E−W cross−section

It can be clearly seen from the cross-section in Figure Five that the depth of the earthquakes around Chile formed a clear slope in the graph, which indicated that the plate near Chile shifts downward to go East.

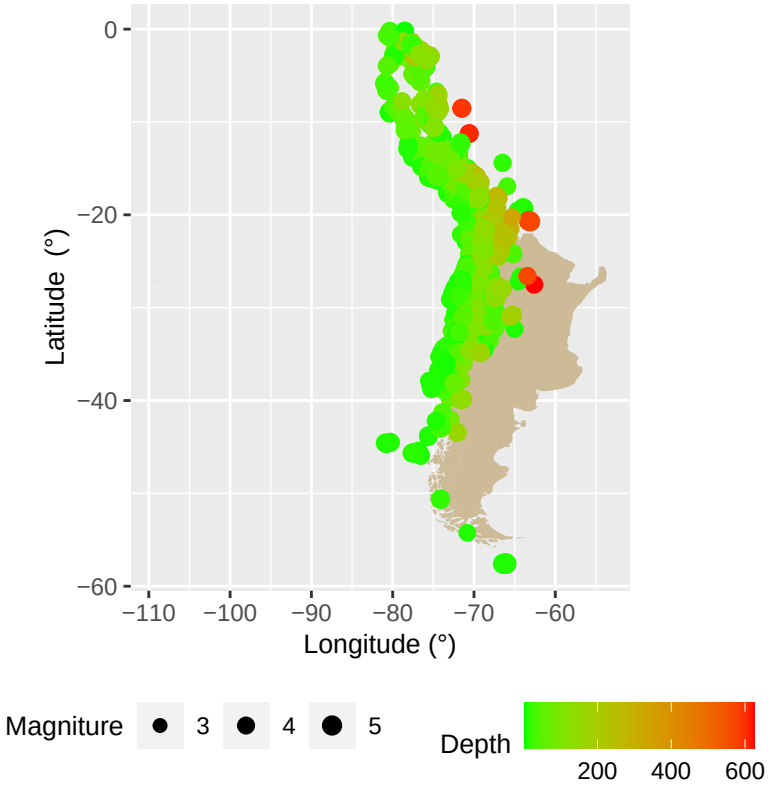

Figure Four: South America Coastal Region

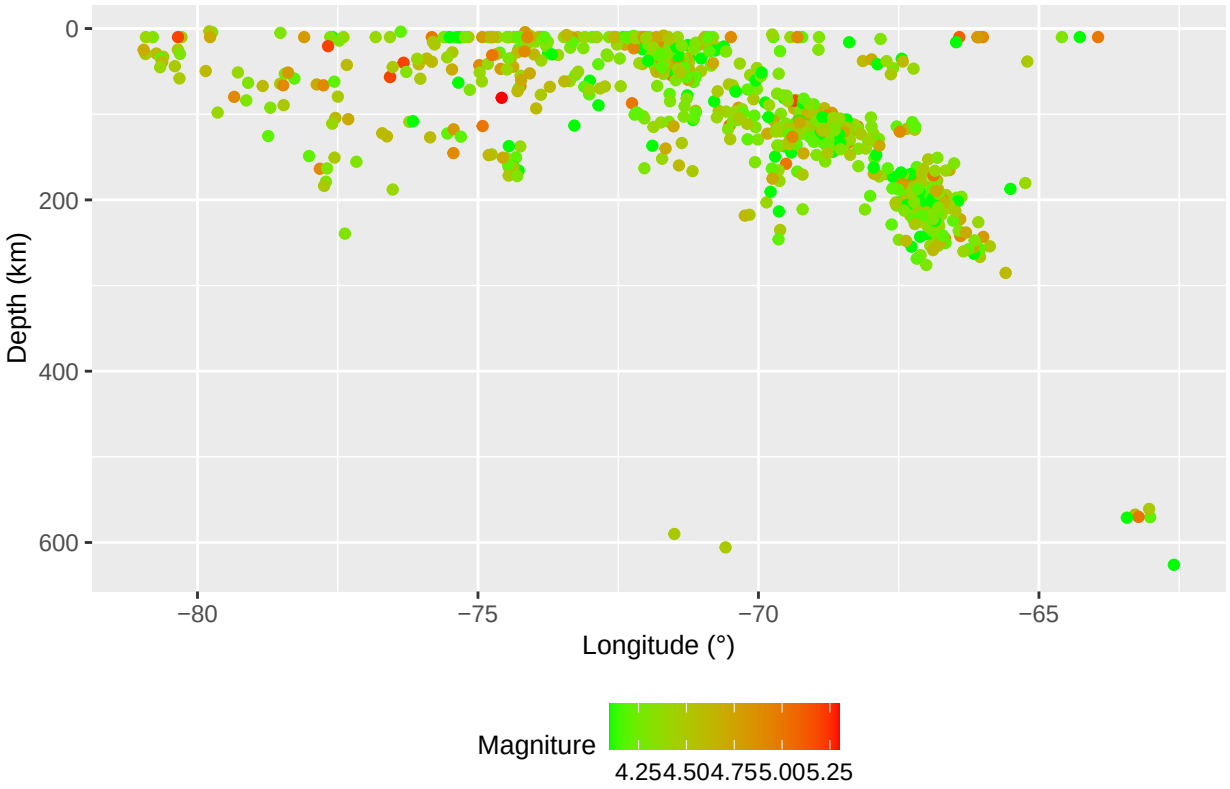

Figure Five: cross−section South America

Discussion

By analyzing and comparing the data clusters of earthquakes of the Pacific Northwest and Chile, it can be found that these two coastal areas are located at subduction zone. It can be seen from Figure One and Figure Four that the earthquakes in these two regions are mainly concentrated in the vicinity of where the plate meets the coastal mountain range, the Pacific Northwest and Chile, Peru, and Argentina.

Comparing Figure three and Figure five's cross-section, we can see the difference in the shape of each of the subducting plates. In the Pacific Northwest, most of earthquakes are close to the surface. However in Chile, because there is a Peru-Chile trench that extends to South America under the coast of Chile. A long subduction zone forms between multiple plates, causing earthquakes to occur in this region deeper than pacific northwest.

Conclusion

By comparing the distribution of earthquakes in the two regions (pacific northwest vs Chile), it can be concluded that earthquakes are mainly concentrated in the vicinity of the subduction zone and therefore relate to tectonics. Depth of earthquakes along the subduction zone is higher than that in other places.

References Cited

USGS. (n.d.). API documentation - earthquake catalog. U.S. Geological Survey. Retrieved January 25, 2022, from https://earthquake.usgs.gov/fdsnws/event/1/

Appendix - R Code

```
# clear the decks
rm(list = ls(all = TRUE))
# set up directory
SaveFile <- "C:/Users/tulou/Desktop/PSU_Classes/G_324/Assignment_Two"
# need to use ggplot2 and map_data, so we need the tydiverse, maps, mapdata
library(tidyverse) library(maps) library(mapdata)
# Download the map data
website <- "https://earthquake.usgs.gov/fdsnws/event/1/query"
qryFormat <- "format=csv"
qryStime <- "starttime=2018-01-01"
qryEndtime <- "endtime=2018-12-31"
qryMinlat <- "minlatitude=41"
qryMaxLat <- "maxlatitude=51"
qryMinLong <- "minlongitude=-129"
qryMaxLong <- "maxlongitude=-116"
qryMinMag <- "minmagnitude="
qryMaxMag <- "maxmagnitude="
qryMinDepth <- "mindepth="
qryMaxDepth <- "maxdepth="
qryLimit <- "limit="
# Concatenate all vectors and use '&' and '?' to seperate
qryStr <- paste(qryFormat, qryStime, qryEndtime, qryMinlat, qryMaxLat, qryMinLong, qryMaxLong, sep = "&")
webQuery <- paste(website, qryStr, sep = "?")
# download file and save as .csv file
targetFile <- "EarthquakeFile.csv"
download.file(webQuery, targetFile, quiet = TRUE)
eqDF <- as_tibble(read.csv(targetFile, header = TRUE))
# select state's data and Subset Washington and Oregon
mapStates <- map_data("state")
mapUSA <- subset(mapStates, region %in% c("oregon", "washington"))
# Filter data and play with multivariate plots
filteredDFfA <- filter(eqDF, mag>0, type == "earthquake", magType %in% c("mb", "md", "mh", "ml", "mw", "mwr"))
# Question One
QuestionOne <- ggplot() +
```

```
geom_polygon(data = mapUSA, fill = "wheat3", aes(long, lat, group = group)) +

geom_point(data = filteredDFfA, aes(longitude, latitude, color = depth, size = mag)) +

scale_color_gradient(low = "green", high = "red") +
coord_quickmap() +

scale_size(range = c(1, 3)) +

theme_bw() +

#facet_wrap(~magType) +

labs(caption = "Figure One: Spatial Distribution of Earthquakes in the Pacific Northwest", x = "Longitu

theme(axis.title = element_text(size = 10),
      legend.title = element_text(size = 10),
      legend.position = "bottom",
      plot.caption = element_text(size = 20, hjust = 0))
```

Filter data which maginitude is large than 4

filteredDFfB <- filter(eqDF, mag>4, type == “earthquake”, magType %in% c(“mb”, “md”, “mh”, “ml”, “mw”, “mwr”))

Question Two

QuestionTwo <- ggplot() +

```
geom_polygon(data = mapUSA, fill = "wheat3", aes(long, lat, group = group)) +

geom_point(data = filteredDFfB, aes(longitude, latitude, color = depth, size = mag)) +

scale_color_gradient(low = "green",
                     high = "red") +

coord_quickmap() +

scale_size(range = c(1, 3)) +

theme_bw() +

labs(caption = "Figure Two: More Intense Earthquake",
     x = "Longitude (°)",
     y = "Latitude  (°)",
     color = "Depth",
     size = "Magniture") +

theme(axis.title = element_text(size = 10),
      legend.title = element_text(size = 10),
      legend.position = "bottom",
      plot.caption = element_text(size = 20, hjust = 0))
```

Question Three

QuestionThree <- ggplot() +

```
geom_point(data = filteredDFfA,
           aes(x = longitude, y = depth, color = mag)) +

scale_color_gradient(low = "green",
                     high = "red") +

scale_y_reverse() +

labs(caption = "Figure Three: E-W cross-section",
     x = "Longitude (°)",
     y = "Depth (km)",
     color = "Magniture") +

theme(axis.title = element_text(size = 10),
      legend.title = element_text(size = 10),
      legend.position = "bottom",
      plot.caption = element_text(size = 20, hjust = 0))
```

Question Four

qryFormatS <- “format=csv”

qryStimeS <- “starttime=2018-01-01”

qryEndtimeS <- “endtime=2018-12-31”

qryMinlatS <- “minlatitude=-60”

qryMaxLatS <- “maxlatitude=0”

qryMinLongS <- “minlongitude=-81”

qryMaxLongS <- “maxlongitude=-62”

qryMinMagS <- “minmagnitude=”

qryMaxMagS <- “maxmagnitude=”

qryMinDepthS <- “mindepth=”

qryMaxDepthS <- “maxdepth=”

qryLimitS <- “limit=”

#paste(): Concatenate vectors after converting to character. #sep: a character string to separate the terms.

qryStrS <- paste(qryFormatS, qryStimeS, qryEndtimeS, qryMinlatS, qryMaxLatS, qryMinLongS, qryMax-LongS, sep = “&”)

webQueryS <- paste(website, qryStrS, sep = “?”)

targetFileS <- “EarthquakeFileChile.csv”

download.file(webQueryS, targetFileS, quiet = TRUE)

eqDFA <- as_tibble(read.csv(targetFileS, header = TRUE)) view(eqDFA)

mapData <- map_data(“world”)

SouthAmerica <- subset(mapData, region %in% c(“Chile”, “Argentina”, “peru”))

filtereqDFS <- filter(eqDFA, mag > 0, type == “earthquake”, magType %in% c(“mb”, “md”, “mh”, “ml”, “mw”, “mwr”))

#Use ggplot to create a grap for SouthAmerica

QuestionFourFigure <- ggplot() +

```
geom_polygon(data = SouthAmerica,
             fill = "wheat3",
             aes(long, lat, group = group)) +

geom_point(data = filtereqDFS,
           aes(longitude, latitude, color = depth, size = mag)) +

scale_color_gradient(low = "green",
                     high = "red") +

coord_quickmap() +

scale_size(range = c(1, 3)) +

labs(caption = "Figure Four: South America Coastal Region",
     x = "Longitude (°)",
     y = "Latitude  (°)",
     color = "Depth",
     size = "Magniture") +

theme(axis.title = element_text(size = 10),
      legend.title = element_text(size = 10),
      legend.position = "bottom",
      plot.caption = element_text(size = 20, hjust = 0))
```

filtereqDFSA <- filter(eqDFA, mag > 4, type == “earthquake”, magType %in% c(“mb”, “md”, “mh”, “ml”, “mw”, “mwr”))

QuestionFour <- ggplot() +

```
geom_point(data = filtereqDFSA,
           aes(x = longitude, y = depth, color = mag)) +

scale_color_gradient(low = "green",
                     high = "red") +

scale_y_reverse() +

labs(caption = "Figure Four: cross-section South America",
     x = "Longitude (°)",
     y = "Depth (km)",
     color = "Magniture") +

theme(axis.title = element_text(size = 10),
      legend.title = element_text(size = 10),
      legend.position = "bottom",
      plot.caption = element_text(size = 20, hjust = 0))
```