Name: _____

Exercise 11: Valles Caldera: Soda Dam and Battleship Rock (50 points)

Due following Monday 9/24 on Canvas by 11:00 AM as single PDF

Exercise Synopsis

This week we will journey to our local supervolcano, the Valles Caldera. Today's class has two stops (with the potential for more to ooh and ahh at), one to Soda Dam and a second to Battleship Rock. At these two stops, we will reconstruct the events of some of the caldera's explosive activity, and examine some of the lasting impacts of this volcanism that can be observed through to today.

Background Reading and Resources

Most of these are provided for your reference on Canvas, others you may have to search for on Google Scholar or UNM Library. You can use them to go into greater depth on any subject you find interesting or to clear up questions from the class.

Goff, F., Gardner, J. N., Reneau, S. L., Kelley, S. A., Kempter, K. A., & Lawrence, J. R. (2011). Geologic map of the Valles caldera, Jemez mountains, New Mexico. *New Mexico Bureau of Geology and Mineral Resources Geologic Map*, *79*(scale 1), 50.

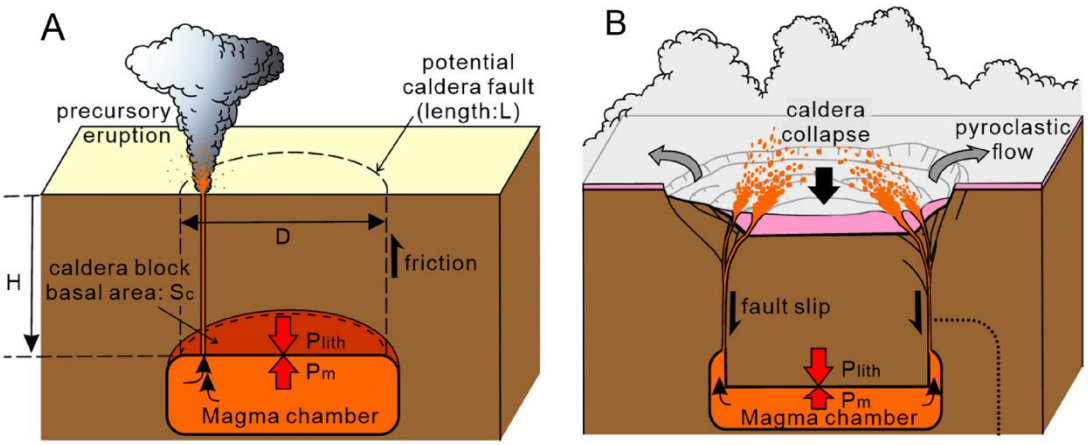
Kelley[1], S. A., Osburn, G. R., & Kempter, K. A. (2007). Geology of Cañon de San Diego, Southwestern Jemez. In *Field Conference* (Vol. 58, p. 169). New Mexico Geological Society.

Wolff, J. A., Brunstad, K. A., & Gardner, J. N. (2011). Reconstruction of the most recent volcanic eruptions from the Valles caldera, New Mexico. *Journal of Volcanology and Geothermal Research*, *199*(1-2), 53-68.

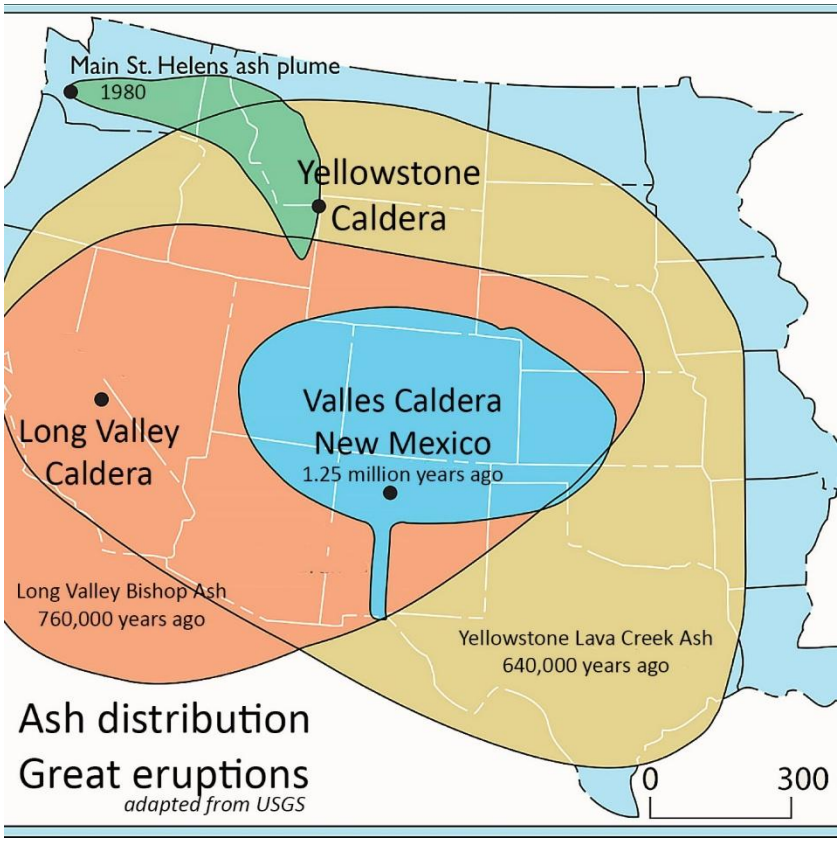
Zimmerer, M. J., Lafferty, J., & Coble, M. A. (2016). The eruptive and magmatic history of the youngest pulse of volcanism at the Valles caldera: Implications for successfully dating late Quaternary eruptions. *Journal of Volcanology and Geothermal Research*, *310*, 50-57.

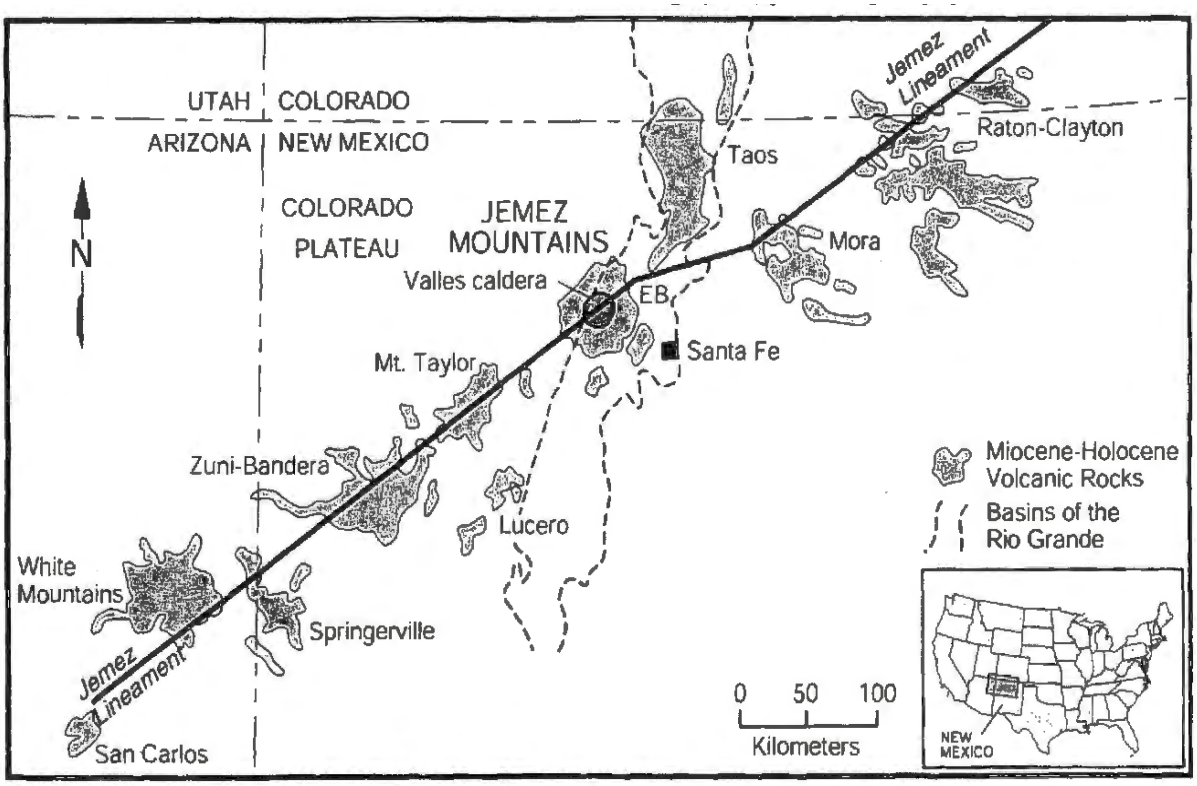
Caldera Volcanism – An Introduction

Calderas are sometimes called "supervolcanoes" due to their large size, explosive nature, and high eruptive volumes. The Valles Caldera is one of the most well-studied caldera systems in the world and is the type locality for a resurgent dome caldera, meaning it is here that this concept was first defined. Calderas are typically characterized by large volumes of material being erupted over a short period of time. This rapid emptying of the chamber destabilizes the walls of the volcano itself and they collapse inward (like a sinkhole) along a ring-shaped fracture.



Unlike with other volcanism observed in New Mexico, the eruption of the Valles Caldera, as with other calderas, was highly explosive. This means that the eruptive products of the eruptive events indicate a much higher energy environment and more rapid cooling. These products include pumices, obsidians, and large ash and tuff deposits called *ignimbrites.*





Questions (45 pts)

General Questions

1. (4 points) The Valles Caldera is located at the intersection of the Rio Grande Rift and the Jemez Lineament. A lineament in this context is a alignment of volcanic features. Why might it make sense that a caldera is formed **here**? Why might there be a lineament in this area to be begin with?
2. (4 points) The emergent domes form a circle around the oldest resurgent dome, Redondo Peak. Why do the domes make a circle? The domes also decrease in age from the dome located at ~3:00 to the dome at ~5:00. It is not well understood why this is the case. **Speculate** on why they might be in chronological order.
3. (3 points) There are **at least 2** units in the country rock that we have met before. Name them below and explain why they are visible at the surface here, either in outcrop or as float.
4. (7 points) The Valles Caldera overlies an older one, the Toledo Caldera. Knowing only that it is also a caldera system, in your notebook **sketch** (think comic book style) the sequence of events from the formation of the Toledo Caldera through to today.

Soda Dam

Dissolve $CO_{2(g)external} + H_2O + CaCO_{3(limestone)}$

Transport $\rightarrow Ca^{+2}_{(aq)} + 2HCO_3^-{}_{(aq)}$

Precipitate $\rightarrow CaCO_{3(travertine)} + CO_{2(g)} + H_2O$

5. (3 points) To generate the material that is then precipitated out as travertine, there needs to be a source of CO_2 and limestone. Here, where is the CO_2 coming from and what is the source of the limestone?
6. (3 points) Using the two provided maps, if one were to look for more travertine deposits, or more springs where travertine could be start being deposited, where should we look and explain your reasoning. **Note these locations** (or locations!) on your maps.
7. (2 points) The waters that feed travertines are sometimes referred to as "thermal waters". Since they need to be hot, what is the source of the heat?
8. (5 points) The Jemez River undercuts the main travertine dam here, at Soda Dam. Is it coincidence that this river, the only drainage out of the caldera, runs in this area? Do you think this river is a recent feature or has it been running this course for some time? How would you **test your hypothesis**?

Battleship Rock

1. (4 points) Battleship Rock is an interesting example of "inverted topography". What does this mean and knowing that it is indeed a good example of this, describe what happened to form Battleship Rock.
2. (4 points) In your **notebook,** sketch the units you can observe in battleship rock. Even within units, are they homogenous? How do they change across the thickness?
3. (3 points) How would you describe the structure of the ignimbrite deposits? What are they made of? What do they tell you about how they were deposited? Why is Battleship Rock shaped the way it is?

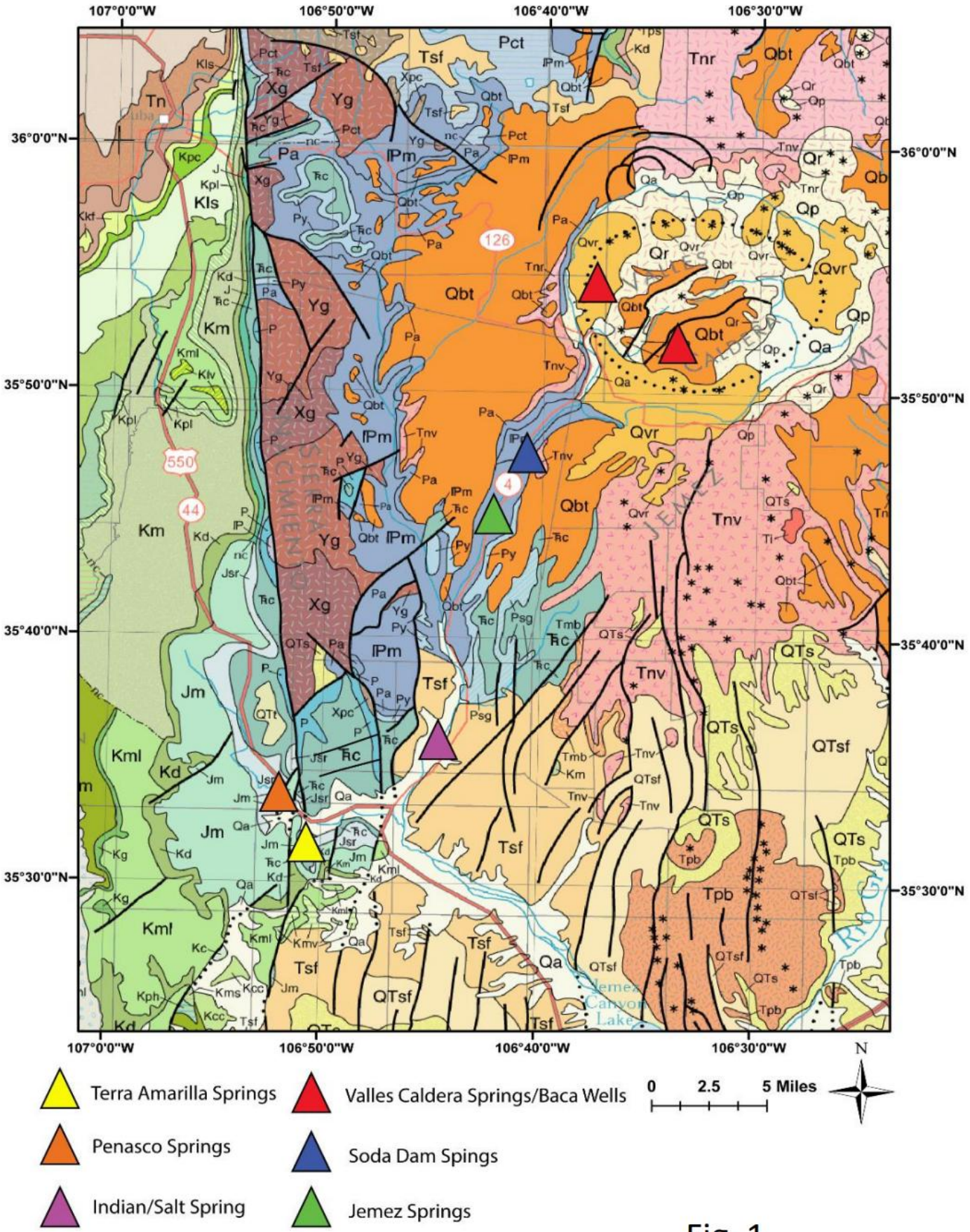
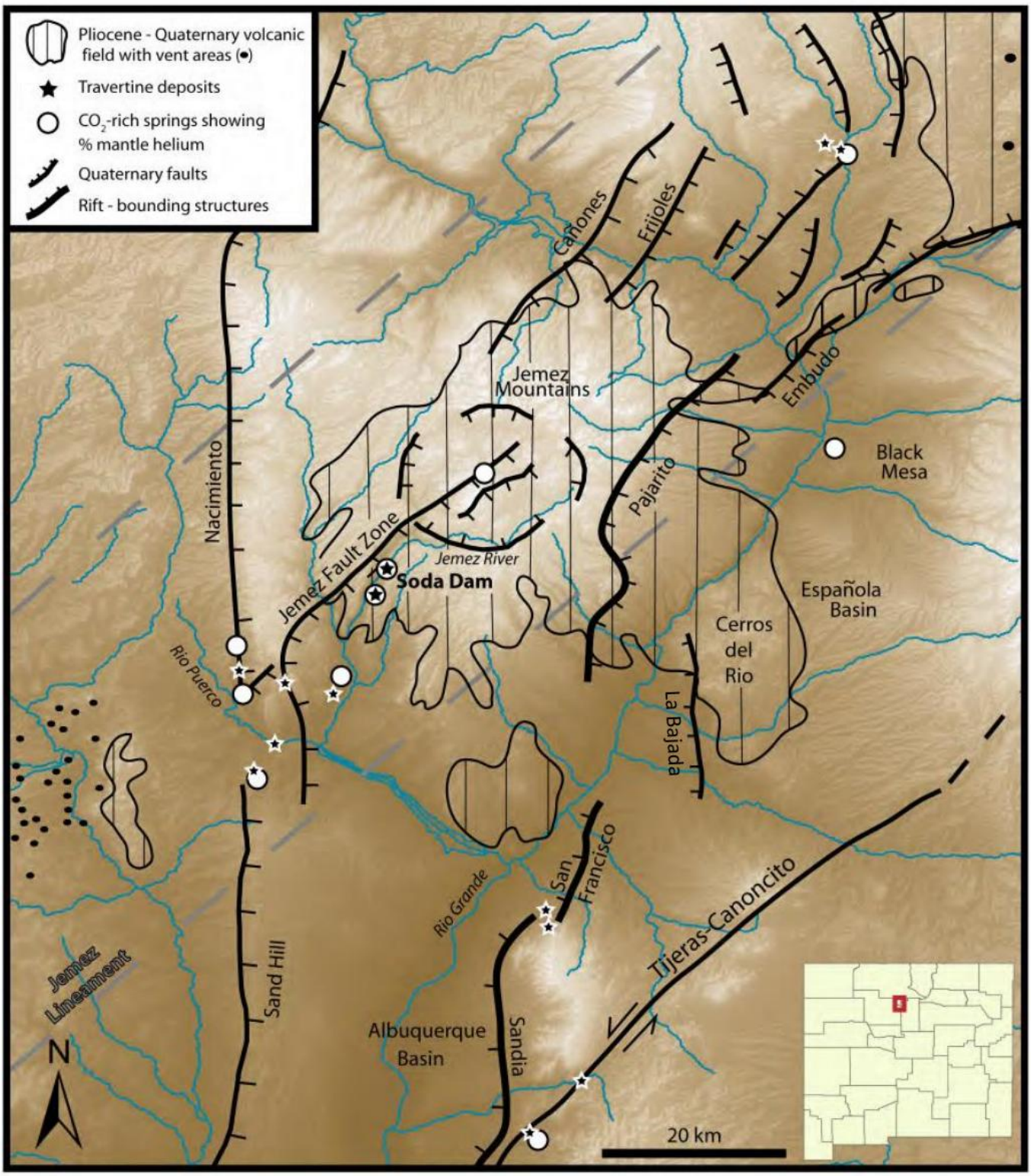

107°0'0"W
106°50'0"W
106°40'0"W
106°30'0"W
36°0'0"N
35°50'0"N
35°40'0"N
35°30'0"N
Terra Amarilla Springs
Valles Caldera Springs/Baca Wells
Penasco Springs
Soda Dam Spings
Indian/Salt Spring
Jemez Springs
0 2.5 5 Miles
N

Fig. 1


Pliocene - Quaternary volcanic field with vent areas (•)
Travertine deposits
CO_2-rich springs showing % mantle helium
Quaternary faults
Rift - bounding structures
Cañones
Frijoles
Jemez Mountains
Embudo
Black Mesa
Nacimiento
Pajarito
Jemez Fault Zone
Jemez River
Soda Dam
Española Basin
Cerros del Rio
La Bajada
Rio Puerco
Rio Grande
San Francisco
Tijeras-Canoncito
Jemez Lineament
Sand Hill
Albuquerque Basin
Sandia
N
20 km

ROCK OF THE WEEK (5 pts)

Name: **Exercise:**

1. Indicate the collection location on any maps associated with the exercise and give its UTM coordinates here (remember to include the UTM zone, datum, and GPS error)?

2. What type of rock is it (sedimentary, igneous, metamorphic)? Circle or underline one in red

3. What minerals are in it, and in what percentages and sizes? If individual minerals are not visible with a hand lens indicate that but also offer an educated guess as to what the most probably minerals in the rock are.

4. What is its texture (remember that many textural terms are reserved for a specific rock type).

5. Name and describe other properties such as color, effervescence, friability, etc.

6. Classify it by rock type (e.g. granite, basalt, gabbro, sandstone, limestone, conglomerate, schist, gneiss, etc.)

7. If sedimentary, what Group, Formation and Member is it from?

8. What do you observe that tells about its processes of formation?

9. What does it tell us about the geologic history of the area?

10. What do you know about its age (Geologic Era, Period, etc. or absolute age in millions of years)?

11. Attach a photo of the outcrop and the hand sample.