“Volcanoes Around the Globe”

Volcanoes fed by relatively silica-rich (SiO_2-rich) magmas tend to explode while those fed by silica-poor magmas usually erupt gently. Where are the explosive volcanoes and where are the “gentle giants?” To answer the preceding question, you will explore the connection between silica content, on one hand, and tectonic plates, on the other. After completing this investigation, you will better-understand the geographic distribution of deadly volcanoes.

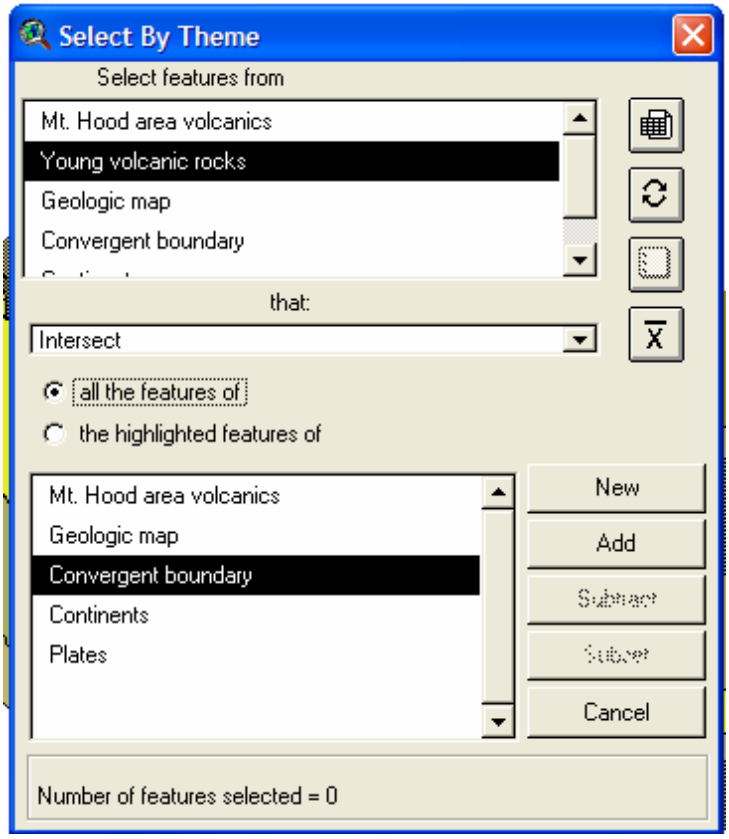
Why explore the connection between volcanic activity and silica content?
Geologists examine the silica content of a volcano’s rocks to understand the mountain’s potential for future violent activity. At Middle Tennessee State University (MTSU), undergraduates working with Dr. Warner Cribb use an X-ray Fluorescence Spectrometer (XRF) to measure silica and the other chemical constituents of volcanic rocks, working mostly around Mount Hood, Oregon. The XRF was purchased with funding from the National Science Foundation and the State of Tennessee. If you would like to learn more about geochemistry at MTSU, visit http://mtsu32.mtsu.edu:11407/xrflab.html . (You do not have to visit the preceding URL to complete this assignment.)

Mount Hood, Oregon (USGS photo by Lyn Topinka.)

I. Plate tectonics and volcanic activity

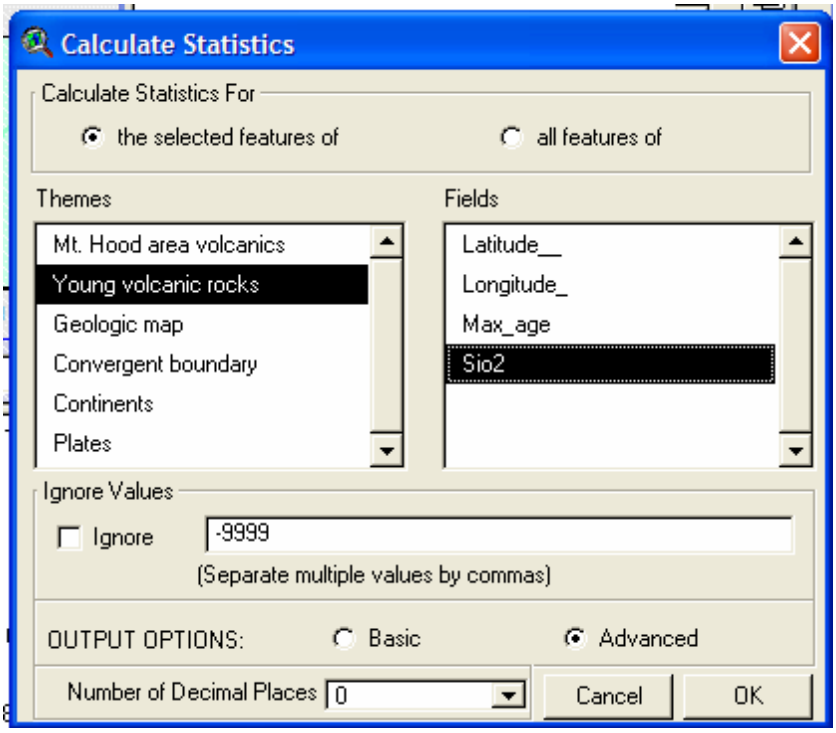
First, explore the relationship between convergent plate boundaries and the amount of silica in volcanic rocks by following the bulleted instructions below.

- ► Turn on and activate the **Young volcanic rocks** theme (if it isn't already turned-on and activated).
- ► Click on the *Select by theme* button  . (Look in the middle of the upper row of buttons). Set the Select by Theme window to read "Select features from **Young volcanic rocks** that **Intersect all the features of Convergent boundary**" as shown below. After setting up the window correctly, click on the *New* button. DO NOT DISMISS THE SELECT BY THEME WINDOW.



► On the Select by Theme window, click on the Theme Statistics button  .

► Set the Calculate Statistics window so that it reads "Calculate Statistics For **the selected features of** Themes **Young volcanic rocks** and Fields **Sio2**" as shown below. Set OUTPUT OPTIONS to **Advanced** and Number of Decimal Places to **0**. Finally, click the *OK* button.



I.1. Copy the following from the Statistics for Sio2 window:

Median _____
(The median is a measure of the middle value. Half of the samples contain less silica than the median sample and half contain more.)

I.2. Compositionally, rocks are classified as ultramafic, mafic, intermediate or felsic according to the following criteria:

felsic . . . . . >65% SiO_2
intermediate . . . . 52%-65% SiO_2
mafic . . . . . 45%-52% SiO_2
ultramafic . . . . . <45% SiO_2

The median volcanic sample within 500 km of a convergent plate boundary is _____.
a. ultramafic b. mafic c. intermediate d. felsic

I.3. A common volcanic rock with the median silica content (answer to preceding question) is _____. (If necessary, look at p. 58 and 59 in Tarbuck and Lutgens.)
a. rhyolite b. andesite c. basalt d. granite e. diorite

I.4. Examine the histogram. Are mafic, intermediate and felsic rocks all present within 500 km of a convergent plate boundary?
a. yes b. no

NEVER DISMISS THE STATISTICS FOR SI02 WINDOW. (DUE TO A BUG, THE PROGRAM WILL CLOSE IF YOU DO SO.) IF THE WINDOW IS IN THE WAY, MINIMIZE IT OR MOVE IT INTO A CORNER.

Now examine the silica content of volcanic rocks erupted far (>500 km) from a convergent plate boundary.

► On the Select by Theme window, click on the Switch Selection button  . Then click on the Theme Statistics button  .

► Set the Calculate Statistics window so that it reads "Calculate Statistics For **the selected features of** Themes **Young volcanic rocks** and Fields **Sio2**." Set OUTPUT OPTIONS to **Advanced** and Number of Decimal Places to **0**. Finally, click the *OK* button.

I.5. Copy the following from the Statistics for Sio2 window:

Median _____

I.6. The median volcanic sample at distances greater than 500 km from a convergent plate boundary is _____.
a. ultramafic b. mafic c. intermediate d. felsic

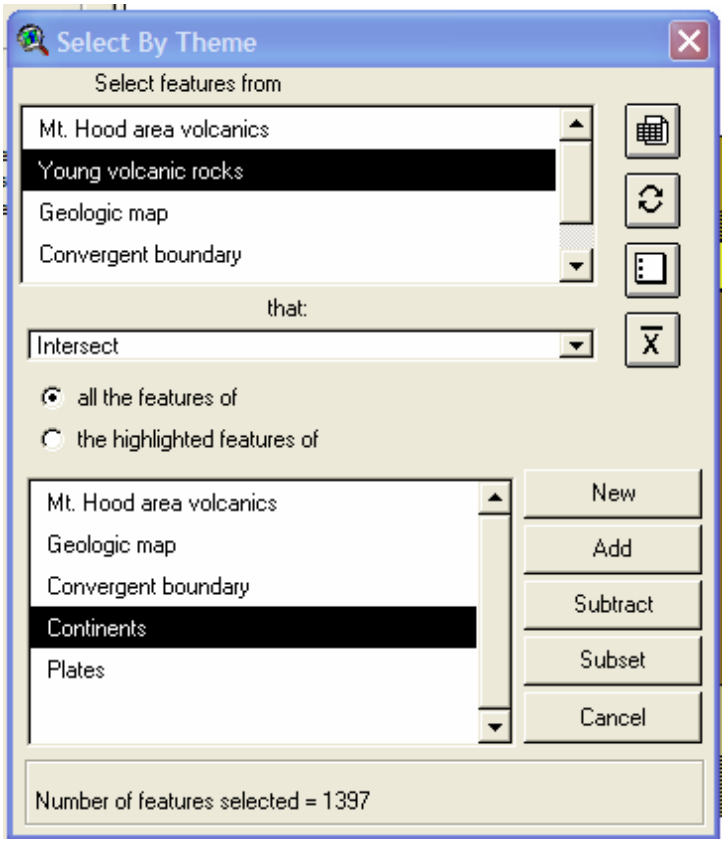
I.7. A common volcanic rock of this type (answer to preceding question) is _____. (If necessary, look at p. 58 and 59 in Tarbuck and Lutgens.)
a. rhyolite b. andesite c. basalt d. granite e. diorite

I.8. Examine the histogram and consider the following statement. No felsic volcanic rocks are found at distances greater than 500 km from a convergent plate boundary.
a. true b. false

► Do NOT dismiss the Select by Theme window.

Second, explore the relationship between crust (continental vs. oceanic) and the amount of silica in volcanic rocks.

► Set the Select by Theme window to read "Select features from **Young volcanic rocks** that **Intersect all the features of Continents**" as shown below. After setting up the window correctly, click on the *New* button. DO NOT DISMISS THE SELECT BY THEME WINDOW.



► On the Select by Theme window, click on the Theme Statistics button  .

► Set the Calculate Statistics window so that it reads “Calculate Statistics For **the selected features of** Themes **Young volcanic rocks** and Fields **Sio2**” as shown below. Set OUTPUT OPTIONS to **Advanced** and Number of Decimal Places to **0**. Finally, click the *OK* button.

I.9. Copy the following from the Statistics for Sio2 window:

Median _____

I.10. The median volcanic rock on continental crust is _____.
a. ultramafic b. mafic c. intermediate d. felsic

I.11. Examine the histogram and then consider the following statement. There are no mafic volcanic rocks on continental crust.
a. true b. false

I.12. Examine the histogram and then consider the following statement. There are no felsic volcanic rocks on continental crust.
a. true b. false

Now examine the silica content of volcanic rocks on oceanic crust.

► Do NOT dismiss the Select by Theme window.

► On the Select by Theme window, click on the Switch Selection button  . Then click on the Theme Statistics button  .

► Set the Calculate Statistics window so that it reads "Calculate Statistics For **the selected features of** Themes **Young volcanic rocks** and Fields **Sio2**" as shown below. Set OUTPUT OPTIONS to **Advanced** and Number of Decimal Places to **0**. Finally, click the *OK* button.

I.13. Copy the following from the Statistics for Sio2 window:

Median _____

I.14. The median volcanic sample collected on oceanic crust is _____.
a. ultramafic b. mafic c. intermediate d. felsic

Putting it all together

To summarize your findings, complete the following table.

	Median SiO_2	**Median rock name**
Within 500 km of convergent boundary		
Greater than 500 km from convergent boundary		
Continental crust		
Oceanic crust		

I.15. Based on your answers to the preceding questions, where are the explosive volcanoes and where are the "Gentle Giants?" Explain their geographic distribution in terms of *both* their proximity to convergent plate boundaries and the kind of crust beneath them (continental vs. oceanic).

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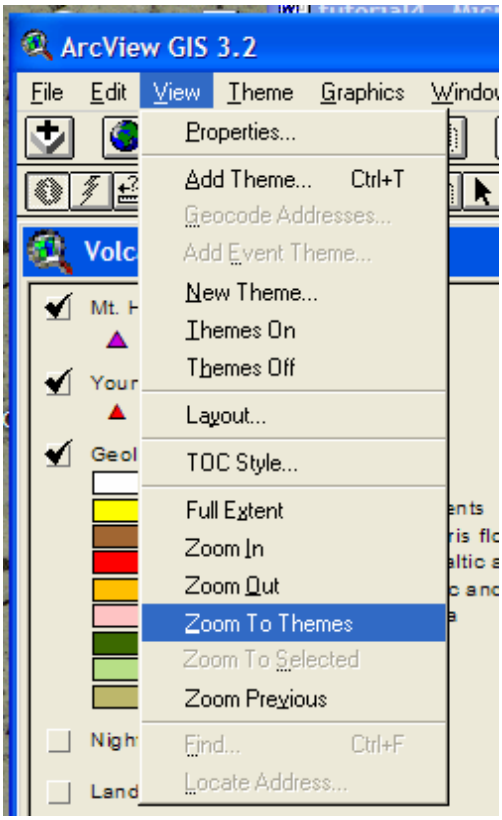
II. A case in point: Mount Hood, Oregon

Now let's examine volcanic hazards at Mount Hood, Oregon – a volcano commonly visited by Middle Tennessee undergraduates during the summer.

► Activate and turn on **Shuttle radar**. (Note that "activate" is different from "turn on." To activate the theme, single left-click anywhere on the word "radar" in the Table of Contents on the left side of the ArcView window.)
► Pull down the View menu and choose Zoom to Themes as shown below.



► Turn the **Geologic map** off, note the location of Mount Hood (it's near the center of the scene) and turn the **Geologic map** back on. Then answer the following question.

II.1. The most common rock(s) at Mount Hood is/are _____.
a. andesite and basaltic andesite
b. basalt and basaltic andesite
c. ejecta
d. intrusive basalt and andesite

► Turn the **Geologic map** off. Turn the **Landsat** image on. Note that snow appears white on the image.

II.2. Mudflows form when snow and ice melt near a volcanic vent during an eruption. Did Mount Hood have the potential to generate mudflows at the time the image was acquired?
a. yes b. no

► Turn on the **Night lights**. These reveal areas of human activity.

II.3. Are humans active on the volcano? Why or why not? (Hint: think about the connection between human recreation, on one hand, and white patches on the Landsat image, on the other.)

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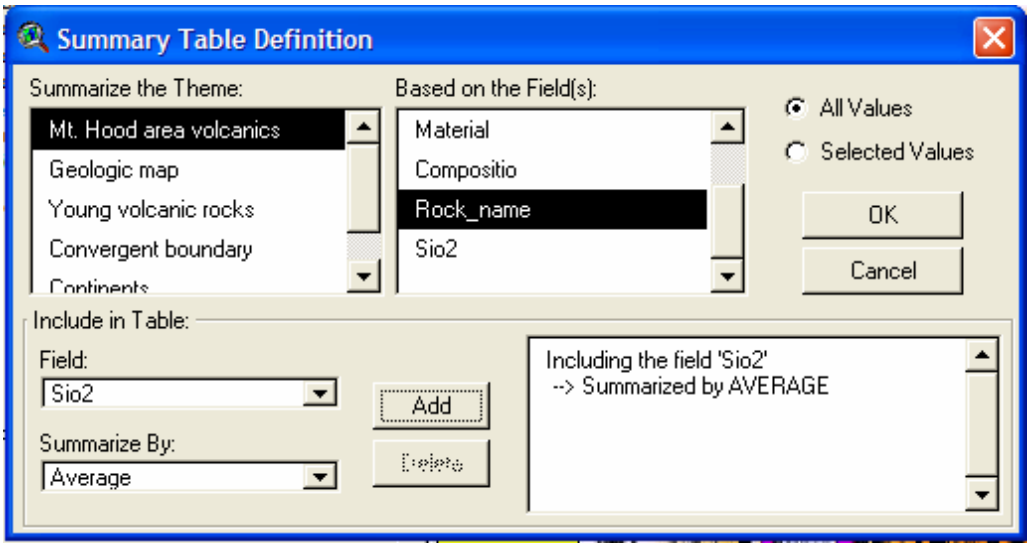
► Activate **Mt. Hood area volcanics**. (Note that "activate" is different from "turn on." To activate the theme, single left-click anywhere on the word "Hood" in the Table of Contents on the left side of the ArcView window.)

► Click on the Summarize button. Set the Summary Table Definition so that you "Summarize the Theme **Mt. Hood area volcanics** Based on the Field **Rock_name**. Use **All Values**. Include in Table Field **Sio2** and Summarize By **Average**. After you have the window set up correctly, click on the *Add* button. After you do the preceding, the window should appear as shown below. Finally, click the *OK* button.



II.4. Use the Summary table in ArcView to complete the table below.

ROCK	AVERAGE SiO_2	COMPOSITION (Felsic, intermediate or mafic)
Rhyolite		
Andesite		
Basalt		

Putting it all together

II.5. Based on your answers to the questions in part II and your knowledge about the relationship between silica and explosive activity, briefly describe volcanic hazards at Mount Hood.

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