

CRUSTAL EVOLUTION EDUCATION PROJECT

Student Investigation

Catalog No. 34W1129

NAME

DATE

Volcanoes: Where And Why?

INTRODUCTION

Geologists group volcanoes by the different kinds of rocks they produce. Some ways in which volcanic rocks differ are in color, texture (size of crystals), mineral composition and chemical composition. Let's look at volcanoes and their rocks in one of these ways.

OBJECTIVES

After you have completed these activities, you should be able to:

- 1.** Tell one way in which volcanoes differ, and use this difference to classify them into certain groups.
- 2.** Explain why groups of volcanoes are different.
- 3.** Show on a map where groups of volcanoes of different kinds are located.

PROCEDURE

PART A. Where are most volcanoes located?

Materials: black pencil

1. Write down the names of all the volcanoes you can think of that are in or around the Pacific Ocean.

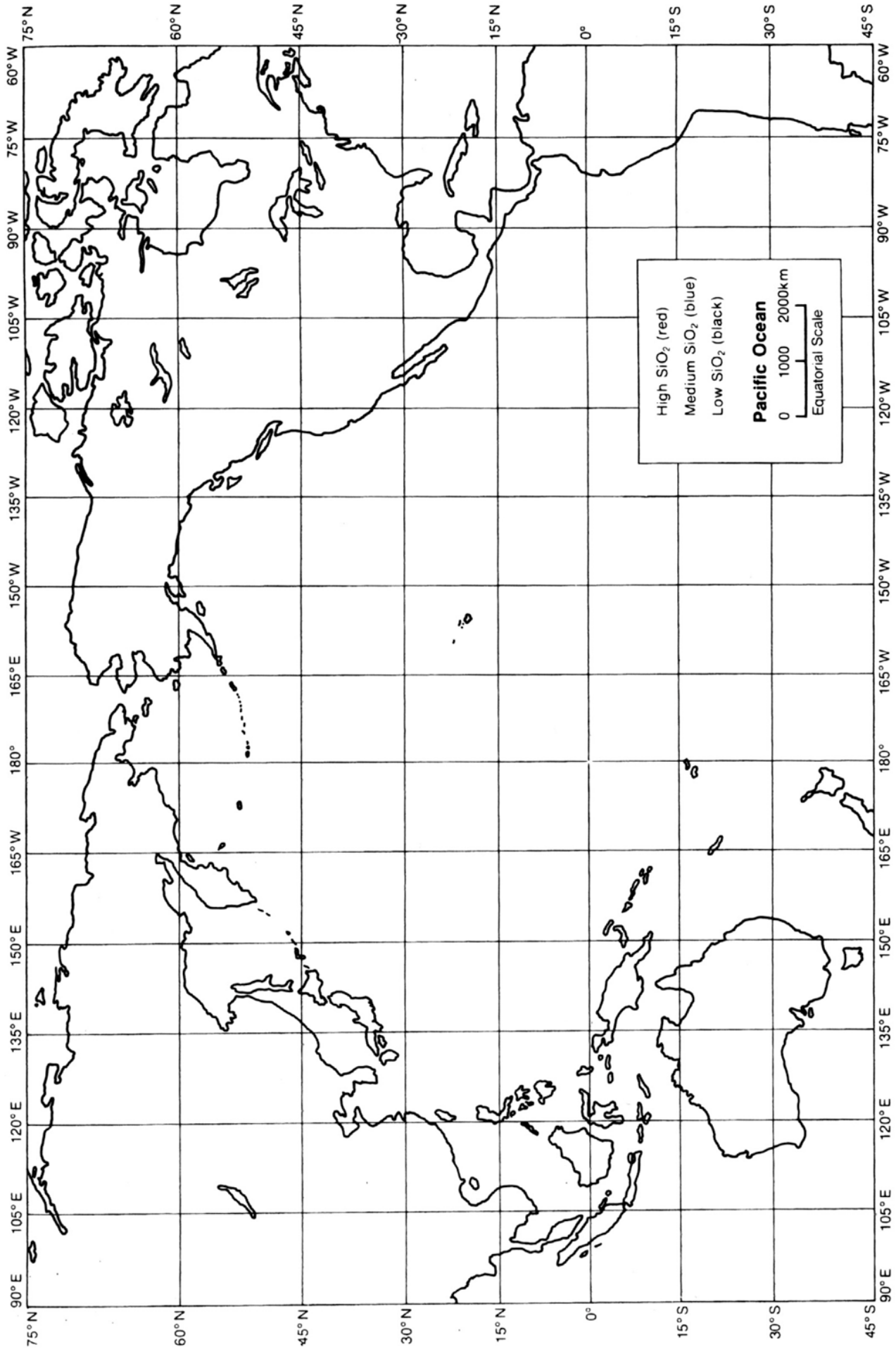
2. Compare your list with the rest of the class.

3. Table 1 lists the locations of 30 volcanoes. You or others in your class may have named some of these. Plot the location of all the volcanoes in Table 1 on the map on the Worksheet. (Use latitude and longitude to find the places.) Write the name of the volcano next to each location.

4. Where are most of these volcanoes located?

Table 1.
Locations of volcanoes

	Latitude (approximate)	Longitude
Western United States, Pacific Border		
Lassen, California	40°N	121°W
Crater Lake, Oregon	43°N	122°W
Mt. Rainier, Washington	47°N	122°W
Mt. Baker, Washington	49°N	122°W
Western United States, Western Interior		
Yellowstone Park, Wyoming	45°N	111°W
Craters of the Moon, Idaho	43°N	114°W
San Francisco Peaks, Arizona	35°N	112°W
Central America and West Indies		
Paricutin, Mexico	19°N	102°W
Popocatepetl, Mexico	19°N	98°W
Mt. Pelee, Martinique	15°N	61°W
Santa Maria, Guatemala	15°N	92°W
Mt. Misery, St. Kitts	17°N	63°W
South America		
Cotopaxi, Ecuador	1°S	78°W
Misti, Peru	16°S	71°W
Alaska and Aleutian Islands Area		
Katmai, Alaska	58°N	155°W
Adak, Aleutians	52°N	177°W
Umnak Island, Aleutians	53°N	169°W
Kamchatka, USSR	57°N	160°E
Japan		
Fuji, Honshu	35°N	139°E
Izu-Hakone, Honshu	35°N	139°E
East Indies		
Mayon, Philippines	13°N	124°E
Krakatoa (between Java & Sumatra)	6°S	105°E
Karkar, New Guinea	5°S	146°E
Central Pacific		
Mauna Loa or Kilauea, Hawaii	19°N	156°W
Galapagos Islands	1°S	91°W
Mariana Islands	16°N	145°E
South Pacific		
White Island, New Zealand	37°S	177°E
Auckland, New Zealand	38°S	176°E
Tahiti	18°S	149°W
Samoa	13°S	172°W



Worksheet (PARTS A and B)

5. Look at the map of crustal plates in Figure 1. Where on the planet are most of these volcanoes located?

6. How can you explain this?

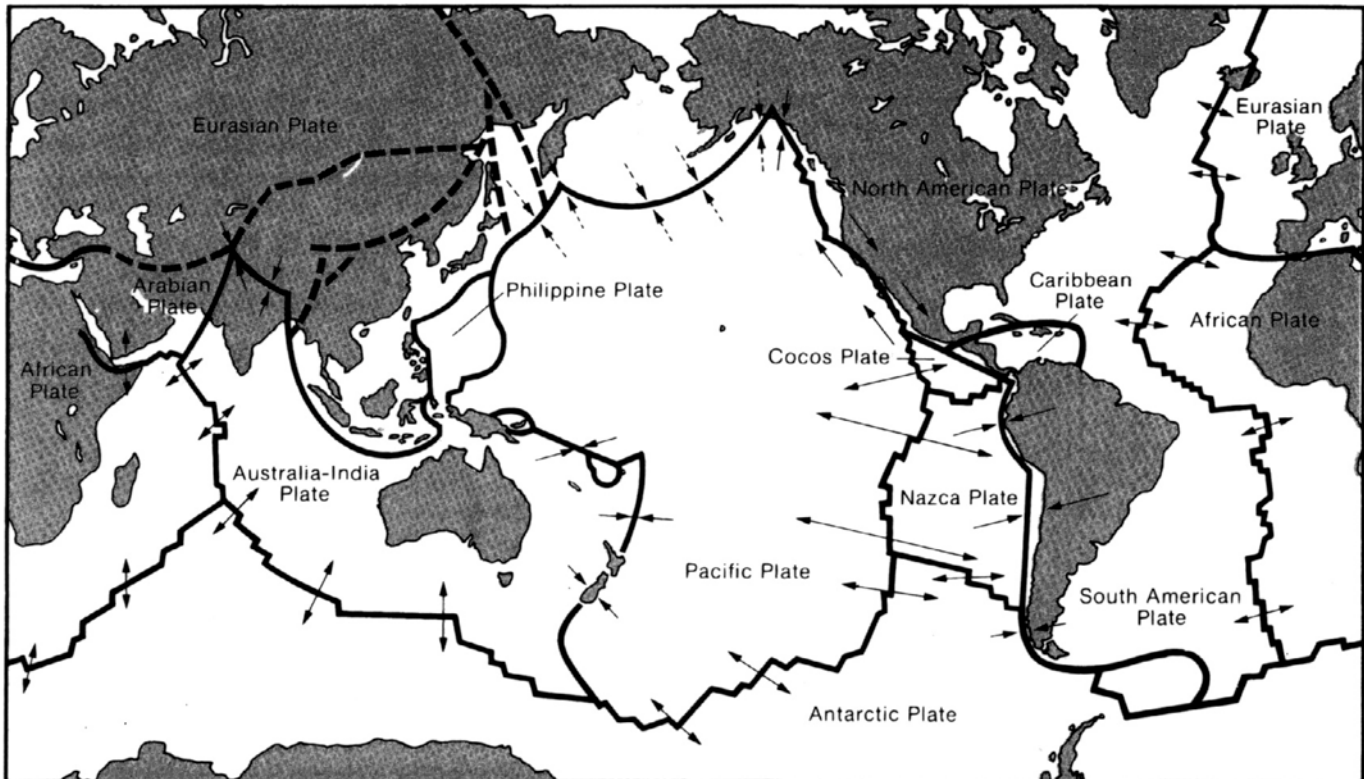


Figure 1. Map of crustal plates. Arrows indicate direction of plate movement.

PROCEDURE

PART B: What makes volcanic rocks different from each other?

Materials: Three pencils (red, black, and blue).

1. List all the ways in which you think volcanic rocks can be different from each other.

2. From your list and the lists of other students, which characteristics of a volcano depend on where the rocks come from more than how the rock material was erupted? When a volcano erupts, rock material may either be exploded out or poured out.

3. Listed below are the complete chemical analyses (by percent) of two volcanic rocks that came from different volcanoes. Look at the information and tell which of the chemical compounds differs by the largest amount.

	Obsidian Cliff, Yellowstone National Park	Basalt, Hawaiian Islands (average)
Si O ₂	75.50	49.58
Al ₂ O ₃	13.25	13.19
Fe ₂ O ₃	1.02	2.40
FeO	0.91	9.49
MgO	0.07	8.30
CaO	0.90	10.69
Na ₂ O	4.76	2.25
K ₂ O	2.85	0.55
H ₂ O+	0.41	—
TiO ₂	—	3.17
P ₂ O ₅	—	.26
	<hr/> 100.05	<hr/> 100.00

When the chemical composition of many volcanic rocks is studied, it is found that silicon dioxide (SiO₂) varies the most. The minerals in the rock, and many of the other things about volcanic rocks, can be related to the SiO₂ content.

For these reasons, one simple classification system for volcanic rocks is based on whether the rock has a high, medium or low amount of SiO₂. This classification system is given below. Examples are listed in parentheses.

- High SiO₂ — more than 66 percent SiO₂
(rhyolite, obsidian, pumice)
- Medium SiO₂ — between 66 percent and 52
percent SiO₂ (andesite)
- Low SiO₂ — less than 52 percent SiO₂
(basalt)

4. Table 2 gives the chemical compositions for the volcanoes listed in Table 1. On the Worksheet enlarge each volcano spot you plotted, with color, to show if it has a high, medium or low amount of SiO_2 . So that everyone in the class can compare their maps, use these colors:

RED for high SiO_2 (more than 66 percent)

BLUE for medium SiO_2 (between 66 percent and 52 percent)

BLACK for low SiO_2 (less than 52 percent)

5. After coloring all of your locations, answer these questions:

a. Where are most of the red dots (high SiO_2) located?

b. Where are most of the blue dots (medium SiO_2) located?

c. Where are most of the black dots (low SiO_2) located?

6. Geologists have found that “low SiO_2 ” rocks underlie most of the oceans, and that most of the continents are made up of “high SiO_2 .” Why do you think the different kinds of volcanoes are located where they are? List the reasons. (Here is a hint: think about what happens at subduction zones.)

Table 2.
Chemical compositions

	SiO ₂	Al ₂ O ₃	FeO+ Fe ₂ O ₃	MgO+ CaO	Na ₂ O+ K ₂ O
Western United States, Pacific Border					
Lassen, California	57.3	18.3	6.2	12.7	11.0
Crater Lake, Oregon	55.1	18.0	7.1	13.2	4.5
Mt. Rainier, Washington	62.2	17.1	5.1	8.1	5.8
Mt. Baker, Washington					
Western United States, Western Interior					
Yellowstone Park, Wyoming	75.5	13.3	1.9	1.0	7.6
Craters of the Moon, Idaho	51.5	14.0	5.2	8.8	5.9
San Francisco Peaks, Arizona	61.2	17.0	5.7	6.9	7.0
Central America and West Indies					
Paricutin, Mexico	55.1	19.0	7.3	11.9	4.9
Popocatepetl, Mexico	62.5	16.6	4.9	8.4	6.1
Mt. Pelee, Martinique	65.0	17.8	4.5	7.5	4.7
Santa Maria, Guatemala	59.4	19.9	5.9	7.0	5.1
Mt. Misery, St. Kitts	59.8	18.3	7.3	9.2	4.5
South America					
Cotopaxi, Ecuador	56.2	15.3	9.7	12.7	6.7
Misti, Peru	60.1	19.0	5.0	7.1	7.2
Alaska and Aleutian Islands Area					
Katmai, Alaska	76.9	12.2	1.4	0.9	7.3
Adak, Aleutians	60.0	17.0	6.9	10.4	4.8
Umnak Island, Aleutians	52.5	15.1	12.8	12.7	4.7
Kamchatka, USSR	60.6	16.4	7.9	8.9	5.0
Japan					
Fuji, Honshu	49.8	20.6	11.2	15.4	1.9
Izu-Hakone, Honshu	53.8	14.8	13.0	13.5	2.7
East Indies					
Mayon, Philippines	53.1	20.0	8.2	13.1	4.2
Krakatoa	67.3	15.6	4.3	4.0	7.0
Karkar, New Guinea	60.1	16.4	9.6	10.4	2.6
Central Pacific					
Mauna Loa or Kilauea (average), Hawaii	49.6	13.2	11.9	19.0	2.8
Galapagos Islands	48.4	15.4	11.8	18.1	3.2
Mariana Islands	51.2	17.3	10.9	15.9	3.3
South Pacific					
White Island, New Zealand	62.2	14.3	6.0	9.8	4.9
Auckland, New Zealand	49.3	15.6	11.9	18.0	4.1
Tahiti (average)	44.3	14.3	12.4	19.6	5.1
Samoa (average of 5 flows)	48.4	13.3	12.3	15.9	5.0

SUMMARY QUESTIONS

1. How do volcanic rocks differ in composition?

2. How is the composition of volcanic rocks related to their location on crustal plates?

EXTENSION

Find the location of volcanoes in other parts of the world. Using the plate boundary map in Figure 1, tell whether each of those volcanoes should be high, medium or low in SiO_2 .

REFERENCE

Grove, N., 1977, Vestmannaeyjar, up from the ashes. *National Geographic*, V. 151, no. 5 (May), p.691-701.

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