

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE

<http://studentorgs.vanderbilt.edu/vsvs>

Igneous Rocks

2018-2019 VINSE/VSVS Rural

Goal: To introduce students to the types of igneous rocks, how they form, and what minerals combine to form them.

Fits Tennessee Standards

VSVSer Lesson Plan

I. Introduction – What are Igneous Rocks?

- A. Definitions – How are igneous rocks formed?
- B. Lava versus Magma

II. Examining Igneous Rocks

- A. Intrusive vs. Extrusive Igneous Rocks
- B. Basaltic vs. Granitic Rocks
- C. Minerals of Igneous Rocks
- D. Examining Pegmatite

III. Where do these Igneous Rocks come from?

IV. Examining Volcanic Rock

- A. Stratovolcanoes vs. Shield Volcanoes
- B. Special Types of Volcanic Rock
- C.

LOOK AT THE VIDEO BEFORE YOU GO OUT TO YOUR CLASSROOM

<https://studentorg.vanderbilt.edu/vsvs/lessons/>

USE THE PPT AND VIDEO TO VISUALIZE THE MATERIALS USED IN EACH SECTION

Divide class into 16 pairs. Hand out an Igneous Rock observation sheet to each student.

Materials:

- 16 Plastic bags with Igneous Rocks – box #1, A, B, C, D, E, F
- 8 Plastic Cases with two sets of Minerals
- 1 Plastic bag containing 32 samples of Pegmatite total
- 16 Plastic bags with Volcanic Rocks
- 1 VSVS Set of Rocks & Minerals
- 32 Magnify Glasses
- 1 Igneous Rock Observation sheet
- 16 Laminated Mats for Igneous Rocks
- 16 Laminated Venn Diagram mats for minerals in igneous rocks
- 16 Volcano diagrams in sheet protectors

Unpacking the Kit:

VSVSers do this while 1 person is giving the Introduction. Note that students are put into pairs and should have their pencils ready

For Part II: Examining Igneous Rocks

- 16 Plastic Cases containing one set of Igneous Rocks, 1 set of minerals and 1 piece of pegmatite.
- 32 Magnify Glasses

For Part IIB, IIC and IID and Part III: 16 laminated mats for igneous rocks and 16 Venn diagrams.

For Part IV. Examining Volcanic Rocks

16 Volcano diagrams in sheet protectors

Deep plastic box with lid containing: 1 Margarine container, 2 Lids (1 with multiple small holes and 1 with no holes), 16oz of water, Small plastic plate, Small dropper bottle of detergent, Small container of dry ice, A pair of tongs, 2 goggles for VSVSers

For Part B. Special Types of Volcanic Rock

1 clear 16oz cup, 8 Plastic Cases containing two sets of Volcanic Rocks (2 pairs of students will share the case), 16 magnifying glasses from Part III

I. Introduction – What are Igneous Rocks?

Why is the science in this lesson important?

Climate change can cause plenty of different extremely impactful changes to happen to the earth. One recent study found that there is a possibility of increased volcanic activity and a decrease in the amount of magma that can be held by the earth's crust. Another important relevant use for geology is dating in evolutionary biology. Geologists can look at ratios of different iron ions to understand atmospheres of the past and when different species evolved to survive in it.

Learning Goals: Students understand that igneous rocks are formed above and below the earth's surface by cooling melted rock.

Write the following vocabulary on the board: **magma, lava, intrusive igneous rock, extrusive igneous rock, granitic, basaltic, intermediate, mineral, shield volcano, stratovolcano, volcanic rock**

A. Definitions – How are igneous rocks formed?

There are 3 types of rocks - sedimentary, metamorphic and igneous. This lesson focuses on igneous rocks.

Ask students if they know how igneous rocks are formed and what they are formed from.

- Igneous rocks form when the melted rock material from the Earth cools.
- Cooling and hardening of melted rock material can occur on or underneath Earth's surface.

B. Lava Versus Magma

- Tell them that melted rock material is called **magma** when it is *underneath* the Earth's surface. Igneous rocks made from **magma** form *underneath* the Earth's surface and are called **intrusive igneous rocks**
- When the melted material is *on or above* the Earth's surface, it is called **lava**. Igneous rocks formed from **lava** form *on or above* the Earth's surface and are called **extrusive igneous rocks**.

Tell the students that they will:

- Look at different samples of igneous rocks
- Look for visible differences between **intrusive** and **extrusive** igneous rocks
- Learn about some of the different **minerals** that make up **igneous rocks**
- Examine some different types of volcanic rocks and relate them to the type of volcano they come from.

II. Examining Igneous Rocks

Learning Goals: Students identify the differences between different types of igneous rocks and how minerals impact the qualities of each igneous rock type.

Your Notes:

Materials:

- 17 Plastic Cases with one set of Igneous Rocks, 1 set of minerals and 1 piece of pegmatite.
- 32 Magnifying Glasses

A. Intrusive Versus Extrusive Igneous Rocks

Hand out igneous rock, minerals and pegmatite box to each pair and a magnifying glass to each student. Tell students to remove the rocks (A-F) from the box. Leave the minerals and pegmatite in the box.

- Scientists can classify rocks as *fine-grained* or *coarse-grained*. Coarse-grained rocks have large crystals of different minerals, and fine-grained rocks have very small crystals that are difficult to see.
- **Extrusive igneous rocks** cool and harden much more quickly since they form at the Earth’s surface where the temperature is cooler. Since they cool quickly there is not as much time for large, visible crystals to form. **Extrusive rocks are fine grained**
- **Intrusive igneous rocks** form deep within the Earth where they cool much more slowly because the temperature is higher. Crystals have more time to grow larger. **Intrusive rocks are coarse grained.**

Tell students to sort the rocks into 2 sets - fine and course grained.

Ask students what rocks are fine grained and which are course grained.

A, B, C have no crystals and are fine-grained. D, E, F have large crystals and are course-grained.

B. Basaltic Versus Granitic Rocks

- The color of a rock depends on the elements in the minerals in the rock.
- **Granitic (also called Felsic)** rocks are light-colored because they contain minerals that have more silicon, sodium, aluminum and potassium (don’t emphasize elements, focus on the color).
 - Granite is the most common granitic rock.
- **Basaltic (also called Mafic)** rocks are dark-colored and contain minerals that have more calcium, iron and magnesium.
 - Basalt (*buh-salt*) is the most common Basaltic rock.

Tell students to sort the rocks into 2 sets - light-colored and dark-colored.

They might have trouble classifying rocks B and E. Tell the students that these rocks are called **intermediate** because they are made from a mix of Granitic and Basaltic lava.

Ask students which rocks they think are Granitic (*A and D*), Basaltic (*C and F*).

Pass out the laminated mats for igneous rocks AND the Venn diagram (1 per pair).

| | Basaltic/Mafic Igneous Rocks | Intermediate Igneous Rocks | Granitic/Felsic Igneous Rocks |
|---|----------------------------------|--|--|
| Extrusive Igneous Rocks Formed above Earth’s surface from lava | Basalt C <i>(BUH-SALT)</i> | Andesite B <i>(AND-UH-SIGHT)</i> | Rhyolite A <i>(RYE-OH-LIGHT)</i> |
| Intrusive Igneous Rocks Formed below Earth’s surface from magma | Gabbro F <i>(GAB-ROW)</i> | Diorite E <i>(DIE-OH-RIGHT)</i> | Granite D <i>(GRAN-IT)</i> |

Refer to the images as you talk about key terms below

Tell students to place the rocks on the chart, matching the letters to the corresponding spaces.

Walk around and help them to do this as needed.

Your Notes:

Explain that:

- The top row contains **Extrusive Igneous Rocks** that formed from **lava** on the **Earth's surface**. These rocks are fine-grained.
- The bottom row of rocks contains **Intrusive Igneous Rocks** that formed from **magma below the Earth's surface**. These rocks are coarser grained ("speckled"). Students may or may not know that the "specks" are crystals of minerals.
 - The color gradually gets lighter from left to right.
 - The rocks in the blue column are lighter in color and are Granitic
 - The rocks in the red column are darker and are Basaltic.

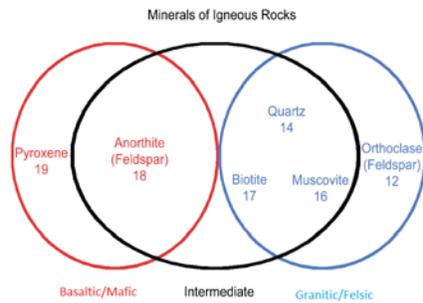
Tell students that the reason for the difference in colors will be more obvious after they have examined the minerals that make up the rocks.

C. Minerals of Igneous Rocks

Learning Goal: Students remember that minerals are the building blocks of rocks

Tell students to place the Venn diagram below the igneous rock mat.

Have the students place the minerals on the diagram, matching the numbers to the corresponding spaces. Remind students that **minerals** are the building blocks of rocks. The igneous rocks are different combinations of these minerals.



The colored circles/ovals in the Venn Diagram correspond to the three columns in the table:

- Any mineral in the blue circle can be found in a granitic/felsic rock.
- Any mineral in the black circle can be found in an intermediate rock.
- Any mineral in the red circle can be found in a basaltic/mafic rock.
- Minerals in overlapping ovals can be found in both corresponding rock types

Ask students:

- What difference do they see in the colors of the minerals?
The color gradually gets lighter from left to right.
- What is the relationship between the color in the minerals and rocks?
The color of the rock depends on the minerals that make up the rock. The minerals that make up the basaltic rocks tend to be darker than those that make up the granitic rocks. Intermediate rocks are made from some granitic minerals and some basaltic minerals.

D. Examining Pegmatite

Tell students to look at the large-grained igneous rocks (D, E and F) and the pegmatite (H) with the magnifying glasses to observe the minerals in them. Note: The name **Pegmatite** refers to an igneous rock with especially large

Your Notes:



mineral crystals. It does not have a specific mineral composition.

Walk through the minerals of the pegmatite with the students:

Using the minerals placed on the Venn diagram as a reference, ask students if they can see: *Orthoclase feldspar, quartz, muscovite, and biotite.*

Note: If the samples have a salmon/pink colored mineral, point out to students that it is a type of orthoclase feldspar (12) that has impurities that makes it pink instead of the white mineral they have in front of them.

Tell students that other minerals are present but that we have listed only the largest/easiest to see.

Based on the minerals listed, ask the students:

Is the pegmatite intrusive or extrusive? *Intrusive because it has large crystals*

Is the pegmatite granitic, intermediate, or basaltic? *Granitic because it's made of the minerals that are found in granitic rocks. It may also be lighter in color.*

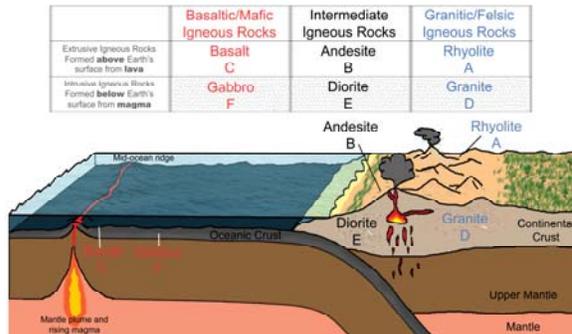
III. Where do these Igneous Rocks come from?

Learning Goals: Students identify the source of different igneous rock types.

Have the students place the rocks on their labels on the landscape diagram below the chart.

Tell students to notice where these rocks are forming.

- Darker basaltic rocks form from cooling of lava or magma from the ocean splitting apart at rifts, also called mid-ocean ridges.
- Lighter granitic rocks form from violent eruptions of volcanoes on land.



Ask the students to put their rocks and minerals back in their boxes so that VSVS volunteers can collect the boxes and the mats while setting up for the next part of the lesson.

VSVS volunteers MUST look at every box before they remove them from the table, to make sure all materials have been put back.

IV. Examining Volcanic Rocks

Learning Goals: Students observe demonstrations to understand how shield and stratovolcanoes can produce igneous rock.

A. Strato and Shield Volcanoes

Pass out one volcano diagram to each pair.



Ask the students if they know the difference between a **shield volcano** and a

Your Notes:

stratovolcano (also known as **Cinder Cone volcanoes**).

Shield volcanoes are broad volcanoes that have slow moving lava flows.

Stratovolcanoes are tall, steep volcanoes that erupt explosively.

Tell students to look at the Volcano diagram handout and explain the difference between the 2 volcanoes

SHIELD VOLCANOES:

- Are named because they look like upside down shields.
- Are spread out over a wide area and are almost continuously erupting.
- Form as lava flows in all directions, cools, and builds up in layers over time.
- Can be found in Hawaii. Lava from Kilauea Volcano was in the news in 2015, as it flowed towards a shopping center.
- Tend to have **basaltic** lava, which flows easily.

STRATOVOLCANOES (Cinder Cone volcanoes):

- Are usually very tall and very steep.
- Erupt explosively all at once, sending out clouds of hot ash and gases as well as flows of lava.
- Mt. St. Helens and Vesuvius – the volcano that destroyed Pompeii – are both stratovolcanoes.
- Stratovolcanoes tend to have **granitic** lava, which flows slowly.

Additional Information for VSVS members:

Stratovolcanoes are more explosive in nature and deadlier. They are often found on shores because of plates moving underneath the Earth's surface. These volcanoes are very dangerous because of ash clouds and pyroclastic flows that form when they erupt. Ash clouds can form a glassy layer inside the lungs, which end up suffocating the victim. Pyroclastic flows are extremely fast and large clouds of hot gas whose temperature can reach up to 300°F and can travel at speeds of 200 miles per hour.

A.Optional – if you can get hold of dry ice!

Demonstration - Stratovolcanoes vs. Shield Volcanoes

Materials:

Deep plastic box with lid containing:

- 1 Margarine container – *you will need to provide these yourself*
- 2 Lids – 1 with multiple small holes and 1 with no holes *you will need to provide these yourself*
- 16oz water
- 1 Small plastic plate
- 1 Small dropper bottle of detergent
- 1 Small container of dry ice
- 1 Pair of tongs

Your Notes:

SAFETY GUIDELINES:

1. **VSVS VOLUNTEERS MUST WEAR SAFETY GOGGLES WHILE DOING THIS DEMONSTRATION.**
2. **KEEP THE MARGARINE CONTAINER IN THE BOX FOR THE STRATOVOLCANO DEMONSTRATION.**
3. **USE THE TONGS TO HANDLE DRY ICE**

Tell students that we will be demonstrating shield volcano and stratovolcano eruptions.

For the shield volcano:

1. Take the margarine container out of the box and place it on the small plastic plate so that the students can see the demonstration better.
2. Fill the margarine container 2/3 of the way full with water.
3. Add one squirt of laundry detergent to the water.
4. Using the tongs, drop 2 pieces of dry ice into the container.
5. Quickly place the lid *with multiple small holes* on top of the container, making sure to press it on fully.

The mixture should start to slowly ooze out of the holes in the lid. Explain that this is similar to how lava in a shield volcano eruption slowly leaves the volcano and slowly flows down around all sides.

For the stratovolcano:

1. Put the margarine container back in the deep plastic box.
2. Make sure the margarine container is 2/3 full of water.
3. Using the tongs, drop 2 pieces of dry ice into the container.
4. Quickly place the lid *without holes* on top of the container, making sure to press it on fully.
5. Step back and watch the lid first bulge and then fly off.

Point out that lid bulges as gas builds up inside the margarine container– this didn't happen with the shield volcano.

This is similar to how gas builds up in a stratovolcano just before it explosively erupts, sending material (and lava) outwards in all directions, just as the lid violently flew off.

Repeat the demonstrations, making sure to point out the slow oozing of the shield volcano demo and the **lid bulging** before the eruption in the stratovolcano demo.

B. Special Types of Volcanic Rock

Materials:

- 8 Plastic Cases with two sets of Volcanic Rocks - (Box #4 – 2 pairs of students will share the case)
- 16 magnifying glasses from Part III

Pass out the cases of volcanic rocks labeled (M-T). Each group of four should get one case that contains two sets of rocks.

Tell students that these are special kinds of igneous rocks called **volcanic rocks** because they come from volcanoes. **All of the rocks in the cases come from stratovolcanoes.**

Have students work with their partner to make observations about each rock.

Your Notes:

As they make observations, they should fill in the chart on the back of their observation sheets.
If time is short, discuss the differences between the rocks as a class and take notes on the board.

While the students are working, walk around and engage them in conversation about what they are observing and make sure that they are recording their observations on their observation sheet.

After a few minutes, have the students stop working, and ask them about their observations.

- Pronounce the name of each rock
- Ask them what they observed or what they think makes the rock unique
- Mention some (**not all**) of the fun facts provided for each rock below.

Volcanic Rock Fun Facts:

M. Vesicular Basalt (*veh-sick-you-ler buh-salt*)

- This rock is made of the same minerals as the basalt we looked at earlier.
- The word *vesicular* means it has small cavities or air pockets because the gas didn't escape before the rock cooled.

N. Scoria (*skur-ree-uh*)

- It is made from lava that had a lot of gases trapped inside.
- These gases form large bubbles in the lava which remain as **holes or cavities** in the solid rock.

O. Pumice (*pum-iss*)

- When lava is extremely rich in gases, it can begin frothing or foaming.
- When this **foam is violently ejected** from the volcano and **solidifies**, pumice is formed.
- Pumice will **float on water**.
- Pumice is commonly used as scouring stones or in exfoliating creams.

Show students that pumice will float – use the 16 oz cup, add water, and add a piece of pumice.

P. Obsidian (*ub-sid-dee-in*)

- Obsidian is also known as **volcanic glass**, and has a **smooth, glassy appearance**.
- It is formed when lava from a volcano **flows into water** (a lake or ocean), which causes it to cool so quickly that **no mineral crystals can form**.
- The red streaks tell us **how the lava was flowing** when it cooled.
- In the past, obsidian was used to make arrowheads and other tools.

R&T. Ash Tuff (*ash tough*) & **Vitric Tuff** (*vit-trick tough*)

- Volcanic tuff is rock formed when **debris** from an explosive volcano piles up and is later **compressed into a solid rock**.
- Sample **R** is called ash tuff because it is mainly composed of **volcanic ash** pressed together to form a solid rock.
- The word *vitric* means glassy, and vitric tuff is made up of bits of volcanic glass (obsidian).

CLEAN UP:

- 1. Collect all volcanic rocks and put into cases in their labeled positions.**
- 2. Collect the volcano diagrams and the magnifying glasses.**
- 3. Empty the liquid from the margarine container.**

Your Notes:

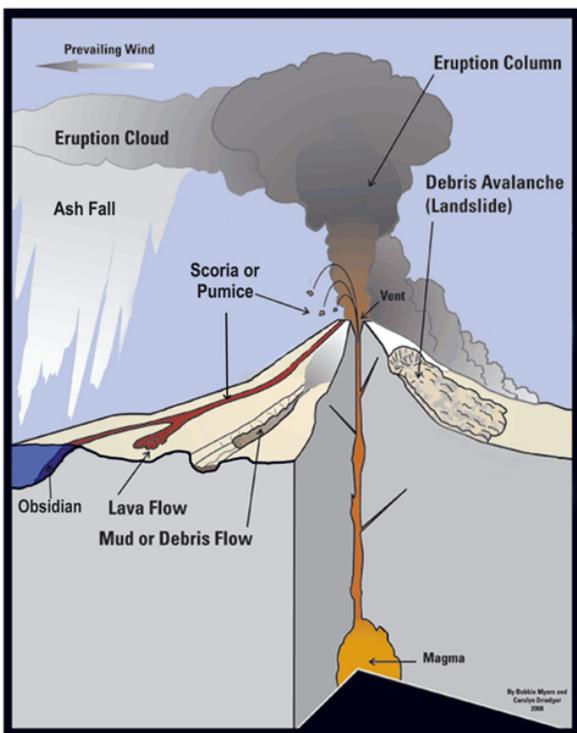
Lesson written by: Pat Tellinghuisen, Coordinator of VSVS, Vanderbilt University
Courtney Luckabaugh, Lab Manager of VSVS, Vanderbilt University
Edited by: Kyle H. Broach, VSVS Training Committee, Vanderbilt University
Lucas Loffredo, VSVS Training Committee, Vanderbilt University
Megan Covington, VSVS President, Vanderbilt University
Reference: Chernicoff, S., & Whitney, D. (2007). *Geology: An Introduction to Physical Geology*.
Upper Saddle River, New Jersey: Pear

Your Notes:

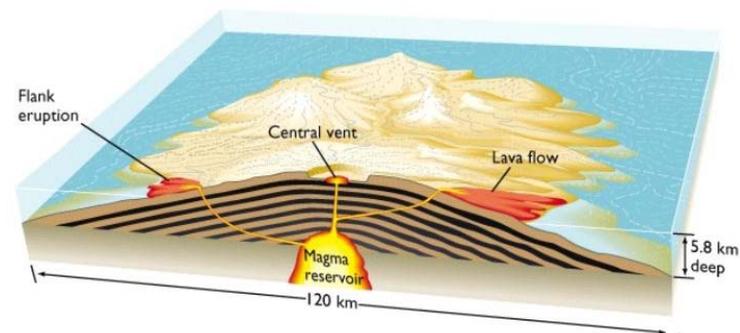
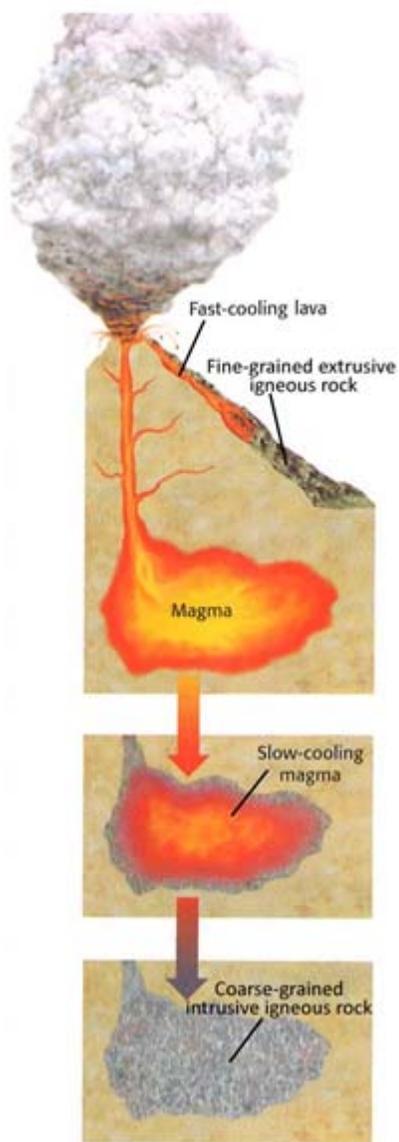
Stratovolcanoes



Mt. St. Helens, Washington



Shield volcanoes



Kilauea volcano, Hawaii

Igneous Rock Observation Sheet

Name _____

I. Introduction – What are Igneous Rocks? – Circle your answer

1. (Sedimentary, metamorphic, igneous) rocks form when melted rock material cools.
2. Igneous rocks formed from lava form *on or above* the Earth's surface are called (intrusive, extrusive) igneous rocks.
3. Igneous rocks formed from magma *underneath* the Earth's surface are called (intrusive, extrusive) igneous rocks.

II. Examining Igneous Rocks

4. Which kind of rock – Granitic or Basaltic – tends to be light in color?

5. In your chart, what differences do you notice between the extrusive igneous rocks in the top row and the intrusive igneous rocks in the bottom row?

6. Circle your answer: The color of an igneous rock is determined by (where it forms, what minerals it is made of, the temperature of the lava around it).

7. What minerals do you observe in the pegmatite sample?

8. Do you think pegmatite is intrusive or extrusive? Why?

IV. Examining Volcanic Rock

| Volcanic Rock: | What do you observe? What makes this rock unique? |
|-----------------------------|--|
| Vesicular Basalt (M) | |
| Scoria (N) | |
| Pumice (O) | |
| Obsidian (P) | |
| Ash Tuff (R) | |
| Vitric Tuff (T) | |

Make observations about the different volcanic rocks. What volcanic rock do you find the most interesting? Why?

Igneous Rock Observation Sheet Answers

I. Introduction – What are Igneous Rocks? – Circle your answer

1. (Sedimentary, metamorphic, igneous) rocks form when melted rock material cools.
2. Igneous rocks formed from lava form *on or above* the Earth's surface are called (intrusive, extrusive) igneous rocks.
3. Igneous rocks formed from magma *underneath* the Earth's surface are called (intrusive, extrusive) igneous rocks.

II. Examining Igneous Rocks

4. Which kind of rock – granitic or basaltic – tends to be light in color? Granitic
5. In your chart, what differences do you notice between the extrusive igneous rocks in the top row and the intrusive igneous rocks in the bottom row? The extrusive igneous rocks in the top row are fine-grained, whereas the intrusive igneous rocks in the bottom row are speckled/have visible crystals.
6. Circle your answer: The color of an igneous rock is determined by (where it forms, what minerals it is made of, the temperature of the lava around it).
7. What minerals do you observe in the pegmatite sample? Orthoclase feldspar, quartz, muscovite, and biotite
8. Do you think pegmatite is intrusive or extrusive? Why? Intrusive because it has large crystals

IV. Examining Volcanic Rock

For the chart, possible answers include the appearances of the rocks, how shiny they are, how heavy they are (pumice should be very light, for example), or anything else observable about the rocks

IGNEOUS ROCKS Instruction Sheet

A. Intrusive Versus Extrusive Igneous Rocks

Remove the rocks labelled A-F (leave the minerals and pegmatite in the box)

Sort the rocks into 2 sets - fine and course grained.

What rocks (A, B, C, D, E, F) are fine grained and which are course grained?



B. Basaltic Versus Granitic Rocks

Sort the rocks into 2 sets - light-colored and dark-colored.

What rocks (A, B, C, D, E, F) are light-colored, and dark colored?



Place the rocks on the chart, matching the letters to the corresponding spaces.

Which kind of rock – Granitic or Basaltic – tends to be light in color? Answer question 4

In your chart, what differences do you notice between the extrusive igneous rocks in the top row and the intrusive igneous rocks in the bottom row? Answer question 5



C. Minerals of Igneous Rocks

Place the minerals on the Venn diagram, matching the numbers to the corresponding spaces.

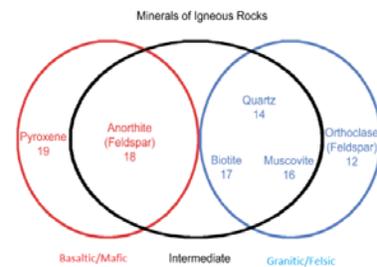
Minerals are the building blocks of rocks. The igneous rocks are different combinations of these minerals.

How does the lightness/darkness (color) of the minerals change from left to right?

Are the minerals in the Basaltic/Mafic rocks light or dark?

Are the minerals in the Granitic/Felsic rocks light or dark?

Answer question 6.



D. Examining Pegmatite

Look at the large-grained igneous rocks (D, E and F) and the pegmatite (H) with the magnifying glasses to observe the minerals in them.

Compare the minerals on the Venn diagram with those in the rocks. Can you identify *Orthoclase feldspar, quartz, muscovite, and biotite*?

III. Where do these Igneous Rocks come from?

Place the rocks on their labels on the landscape diagram below the chart.

Notice where these rocks are forming.

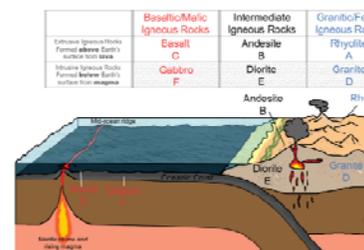
IV. Examining Volcanic Rocks

A. Look at the volcano diagram.

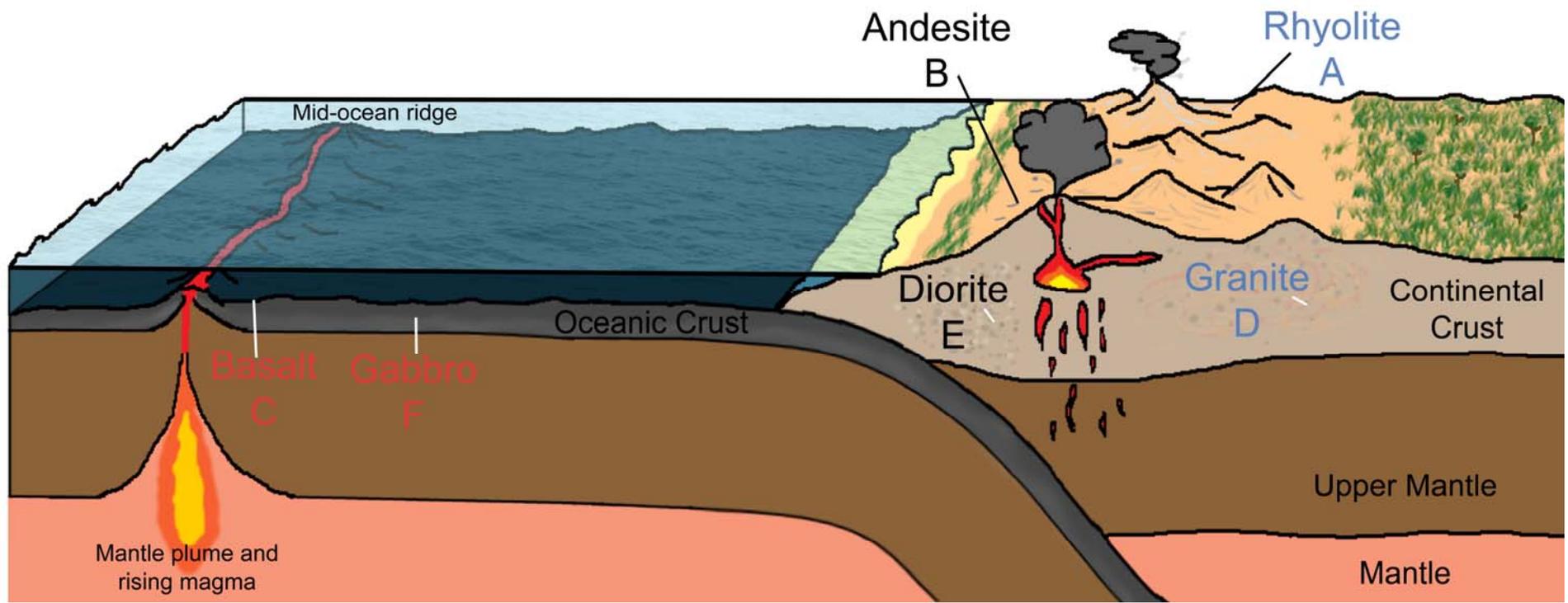
Discuss the difference between Shield volcanos and strato volcanoes.

B. Special Types of Volcanic Rock

Make observations about the different volcanic rocks. What volcanic rock do you find the most interesting? Why?



| | Basaltic/Mafic Igneous Rocks | Intermediate Igneous Rocks | Granitic/Felsic Igneous Rocks |
|---|---------------------------------|-------------------------------|----------------------------------|
| Extrusive Igneous Rocks Formed above Earth's surface from lava | Basalt C | Andesite B | Rhyolite A |
| Intrusive Igneous Rocks Formed below Earth's surface from magma | Gabbro F | Diorite E | Granite D |



Minerals of Igneous Rocks

