Earth Science Rocks! Using Earth Science Activities to Engage Students as Scientists

Missy Holzer, Roberta Johnson, Richard Jones, Russell Kohrs, Joe Monaco, John Moore, Michael Passow, Wendy Van Norden

National Earth Science Teachers Association, Boulder, CO

Fall, 2014

Today (All events in this room)

- 8:00 – 9:00 am – How Weird Can It Get? Developing Weather and Climate Literacy
- 9:30 – 10:30 – Earth Science Rocks! Using Earth Science Activities to Engage Students as Scientists
- 12:30 pm - 1:30 pm – Harnessing the Power of Earth System Science for Developing Science Practices and Crosscutting Concepts
- 2:00 – 3:00 – Using Data in the Earth and Space Science Classroom to Engage Students as Real Scientists
- 3:30 – 4:30 - NESTA Rock and Mineral Raffle

NATIONAL EARTH SCIENCE TEACHERS ASSOCIATION

WINDOWS TO THE UNIVERSE

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http://www.nsta.org/conferences/evaluations

Overview

- NGSS Relevance
- Rock Cycle demonstration
- Let’s Take a Rock Apart – mineralogy of igneous rocks
- Volcano Study

NGSS Relevance

Focus on Performance Expectations associated with Earth materials

- *NGSS PE MS-ESS2.1*: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this.
- *NGSS PE HS-ESS2.1*: Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- Science and Engineering Practices: Analyzing and Interpreting Data; Using Mathematics and Computational Thinking; Constructing Explanations
- Crosscutting Concepts: Cause and Effect; Systems and System Models; Stability and Change

Minerals

- Minerals are the building blocks of rocks.
- Different types of minerals have different crystal shapes. Most minerals can grow into crystal shapes if they have enough space as they grow.
  - **Silicate minerals** are the most common mineral group on Earth, most commonly forming when molten rock cools.
  - **Non-silicate minerals** form in a number of ways, including when magma cools, when water evaporates away, or when other minerals decompose.
- Minerals can be identified by their physical properties.

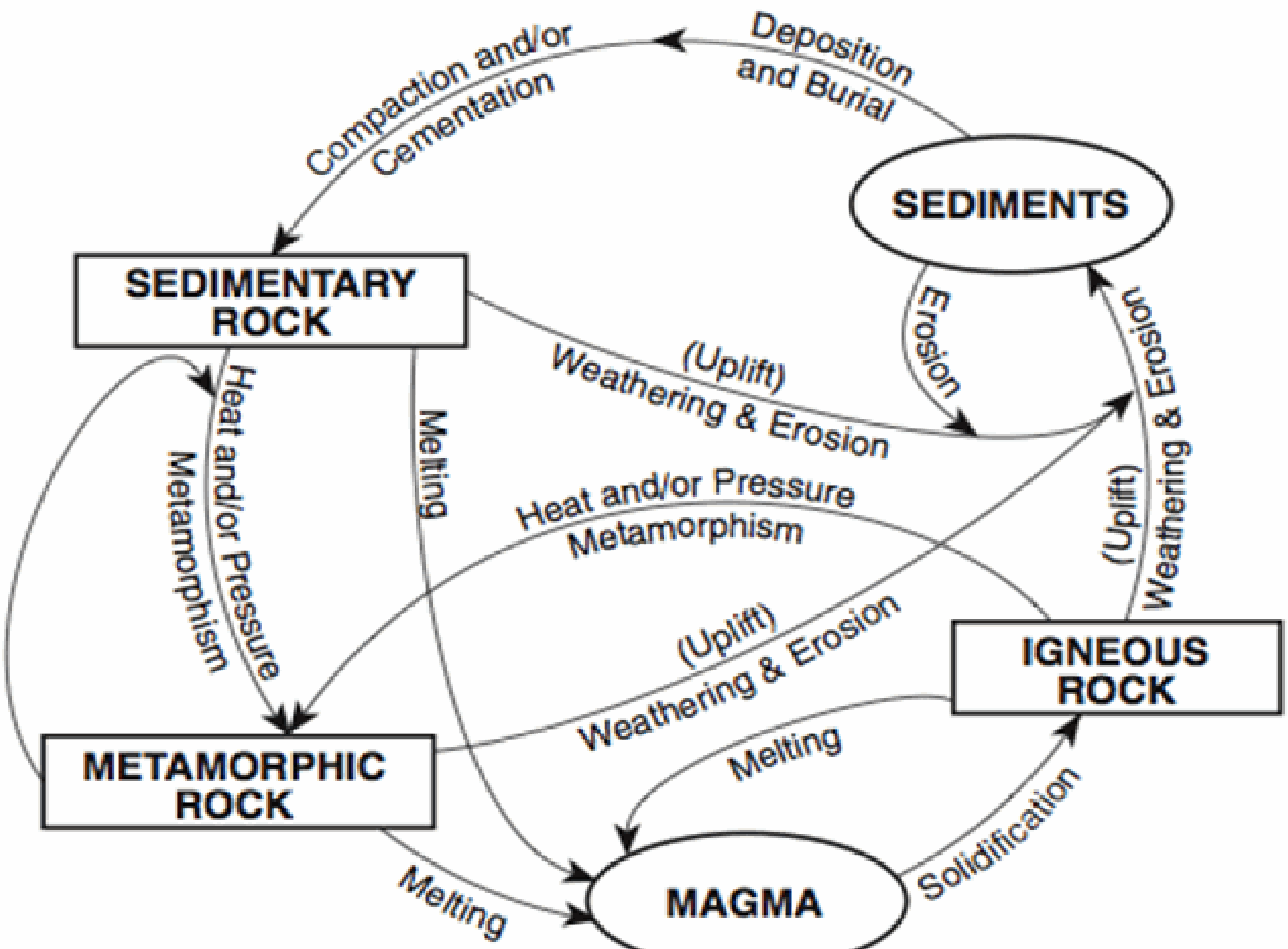
Silicon Tetrahedron, SiO_4^{4-}

- More than 90% of the minerals in the Earth's crust are members of the silicate family.
- In all silicates, the silica tetrahedron is the basic building block.
- The silica tetrahedron consists of 4 Oxygen atoms (raisins) bonded to 1 Silicon atom (bubble blown in middle of pyramid).
- Bonding with other ions allows the charge to be reduced, forming diverse silicate minerals
- Model building allowing students to visualize a complex structure
- Use as a starter for discussion about silicate minerals or crystal structure.

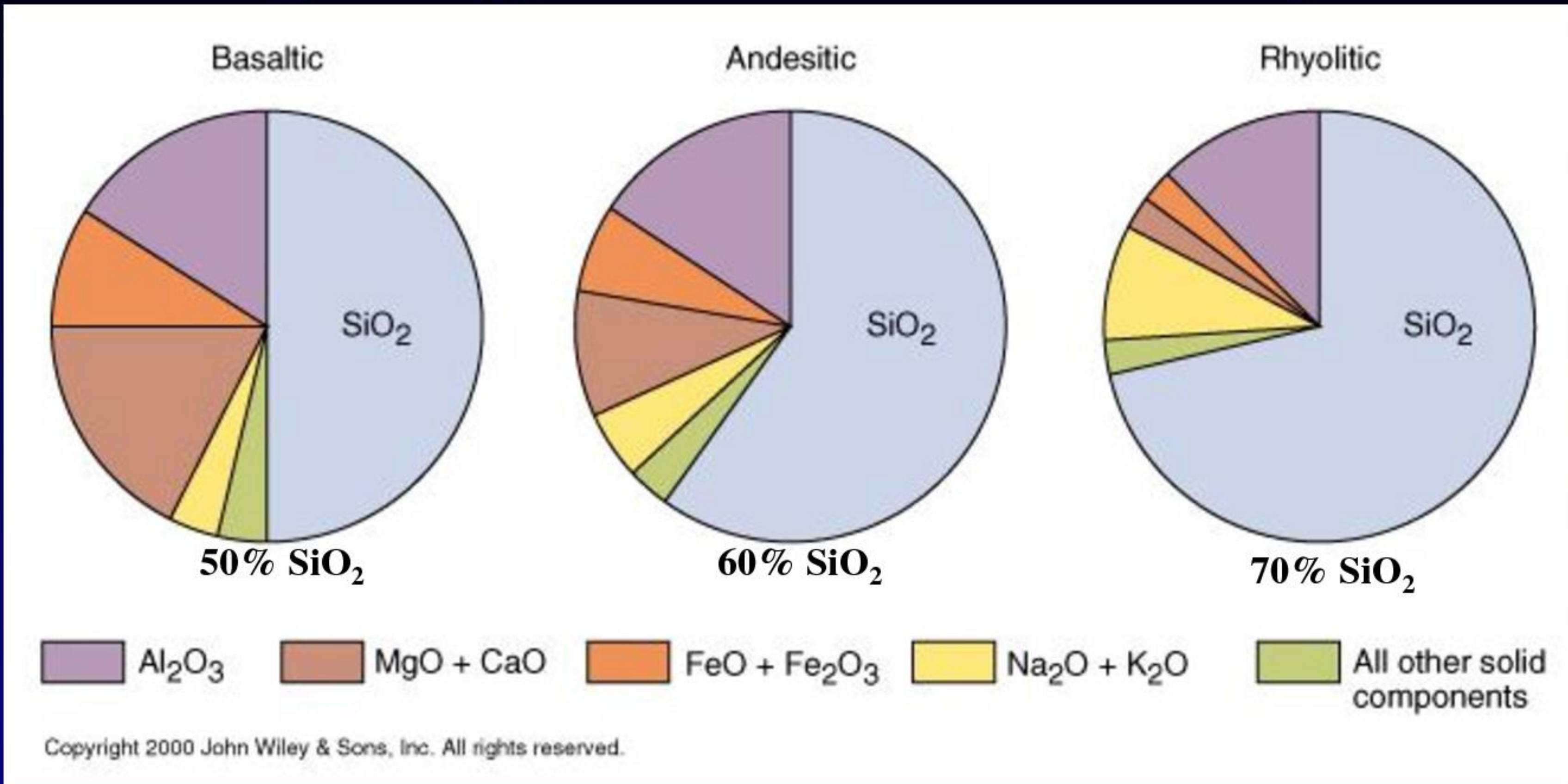
What other common molecules have tetrahedral structure?

- Methane (CH4) and Ammonium ion (NH^+_4)
- The central angle between any two vertices of a perfect tetrahedron is approximately 109.47°)

Rock Cycle in Earth's Crust



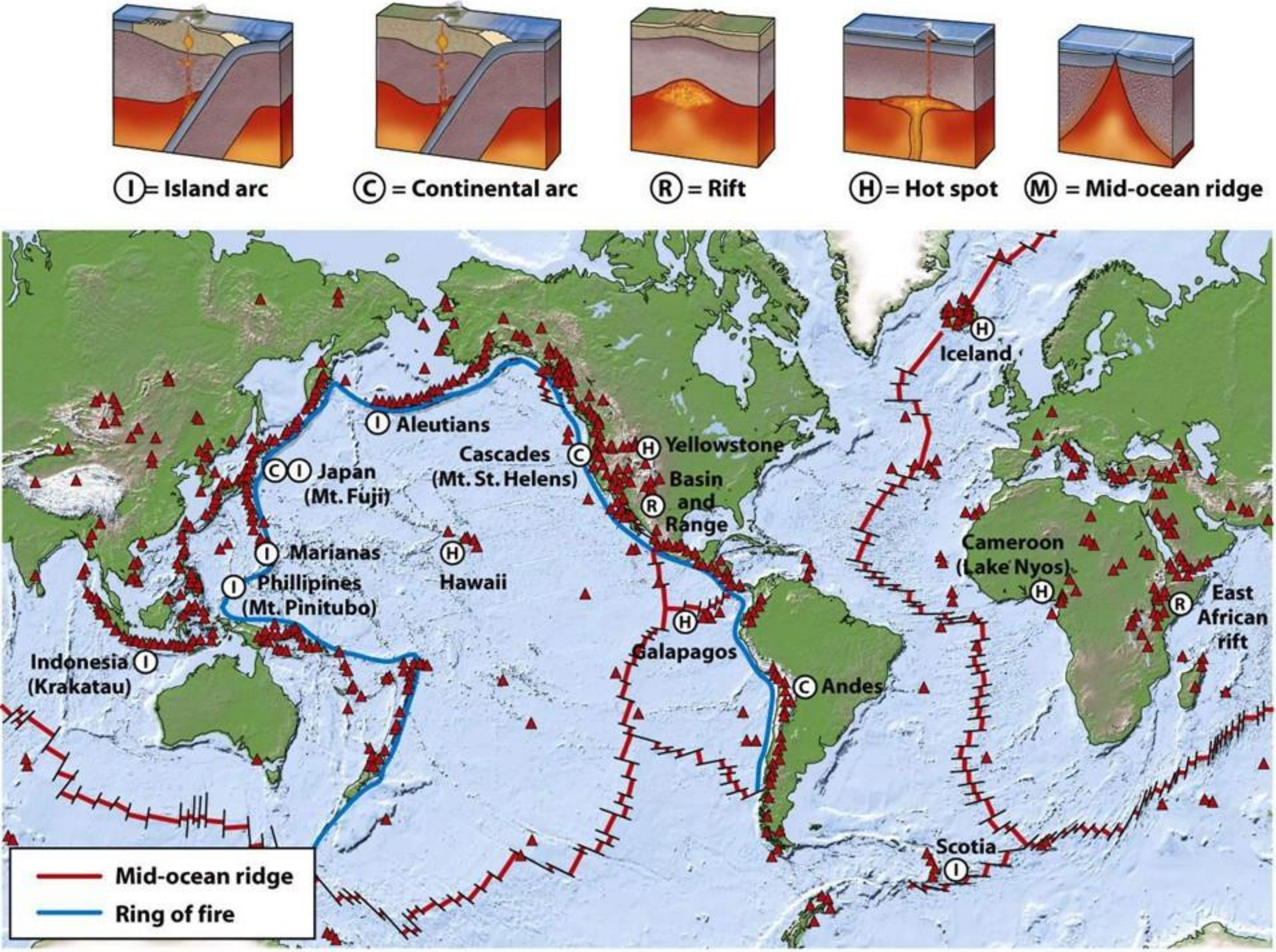
Magma Types Based on Chemistry



gabbro/basalt

diorite/andesite

granite/rhyolite



I = Island arc
C = Continental arc
R = Rift
H = Hot spot
M = Mid-ocean ridge
Iceland
Aleutians
Yellowstone
Cascades (Mt. St. Helens)
Japan (Mt. Fuji)
Basin and Range
Marianas
Hawaii
Phillipines (Mt. Pinitubo)
Cameroon (Lake Nyos)
East African rift
Galapagos
Indonesia (Krakatau)
Andes
Scotia
Mid-ocean ridge
Ring of fire

Rock Cycle Demonstration

Objective: Students will work as a group to develop a physical model to describe the cycling of Earth's materials and the flow of energy that drives this process

Materials:

- Hand samples of granite, obsidian, sandstone (preferably arkose), conglomerate, slate, gneiss
- Clear container with sand
- Lava lamp (or proxy)
- Paper and large marking pen for process labels

igneous
weather
cool
heat + pressure
sediment
lava or magma
lithify
melt
melt
weather
sedimentary
heat + pressure
metamorphic

igneous
melt
cool
weather
heat + pressure
sediment
lava or magma
lithify
weather
melt
melt
weather
sedimentary
heat + pressure
metamorphic

Granite

- The most common type of intrusive igneous rock that we have at the Earth's surface.
- Composed of crystals of common silicate minerals such as quartz, plagioclase feldspar and orthoclase feldspar.
- May also contain small amounts of mica.
- Because granite is very hard, it often used to make buildings, kitchen countertops, tombstones, and sculptures.

Let’s Take a Rock Apart

Objective: Students will take a crushed rock and sort the minerals by color and other properties

Materials:

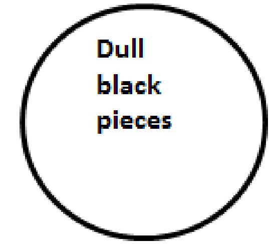
- Mineral specimens - milky quartz, feldspar, mica
- Crushed granite rock - use granite or granite pegmatite
- each student will need 1 hand lens, one or more toothpicks, and a worksheet

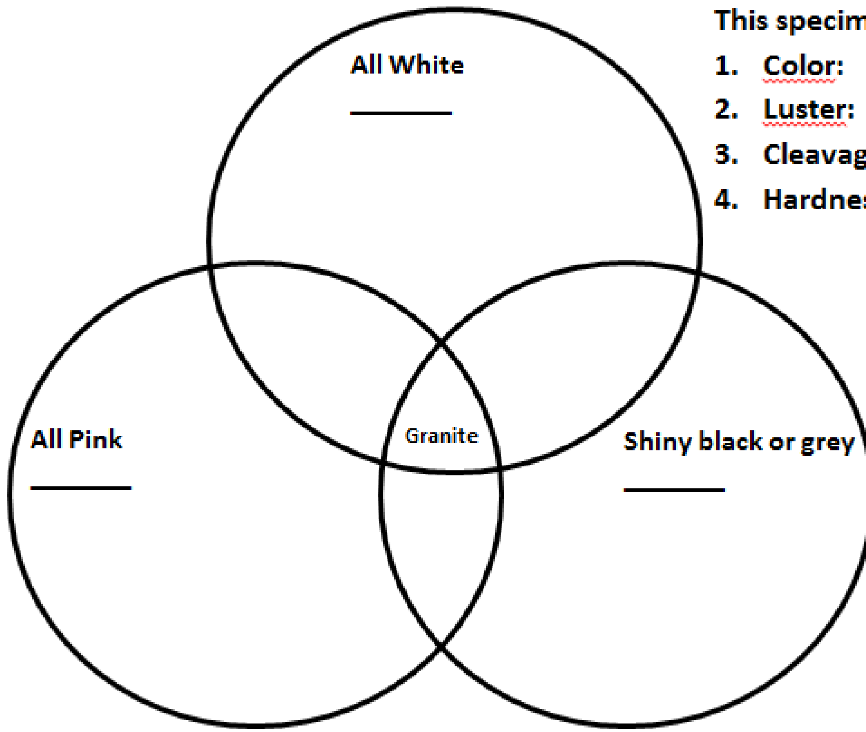
Let’s Take a Rock Apart

Procedure

- Sort the crushed rock (see worksheet)
- Observe and describe the minerals
- Discussion:
  - the processes that transformed granite into sediments (sand), and how this can then be transformed into sedimentary rock
  - uses of granite in buildings and monuments and tombstones
  - Determine % of each mineral class within the granite; compare and come up with class average

Directions: Sort the tiny pieces of crushed rock into the categories named here:





This specimen's attributes:

1. Color:
2. Luster:
3. Cleavage:
4. Hardness:

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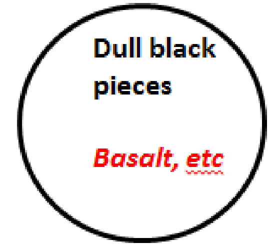
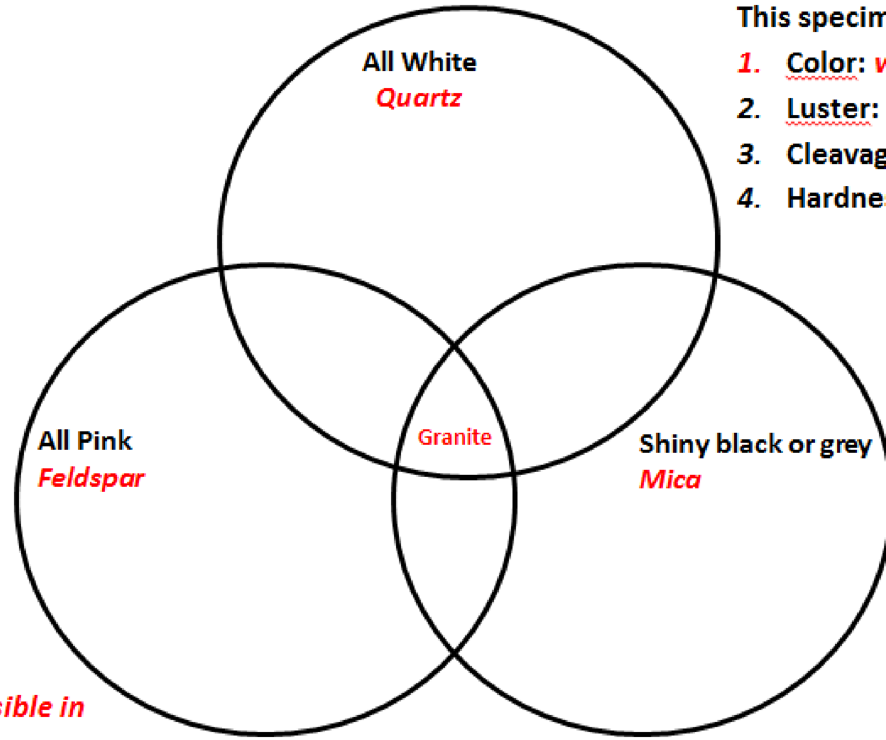


This specimen's attributes:

1. Color: *white*
2. Luster: *glassy*
3. Cleavage: *no*
4. Hardness: *7*



This specimen's attributes:

1. Color: *pink*
2. Luster: *glassy, pearly*
3. Cleavage: *yes (good in 2 directions – may not be visible in grains)*
4. Hardness: *6*

This specimen's attributes:

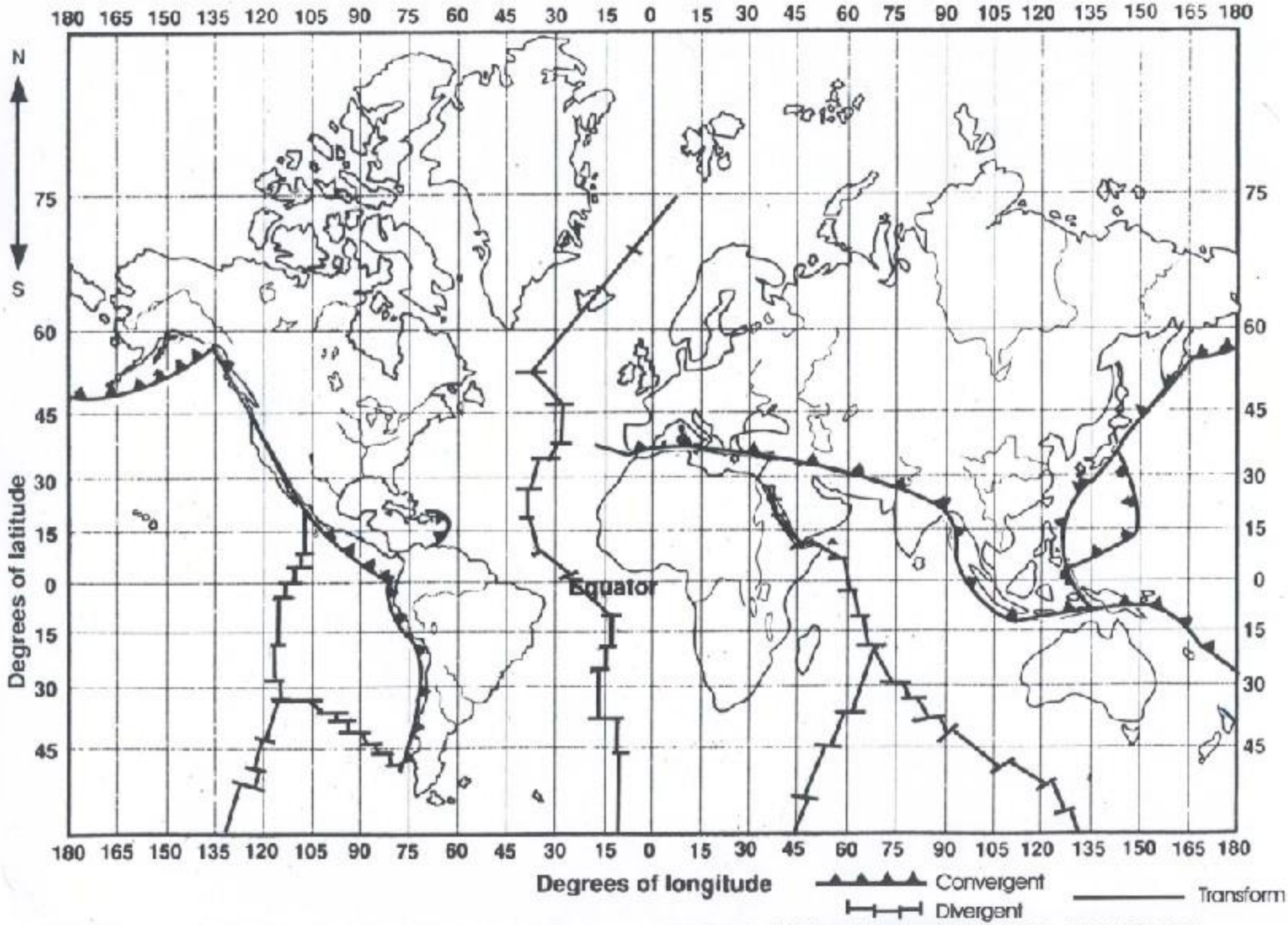
1. Color: *black/gray*
2. Luster: *shiny*
3. Cleavage: *yes (excellent in one direction*
4. Hardness: *2-2.5*

Volcano Study

Objective: Students will develop an understanding of the relationship between volcano location and lava composition through analysis of data

- Materials:
  - World map with tectonic boundaries
  - Volcanic lava composition data
- Procedure – plot each volcano on the map using the correct symbol or color for different SiO_2 content

MAP OF THE WORLD (With plate boundaries)



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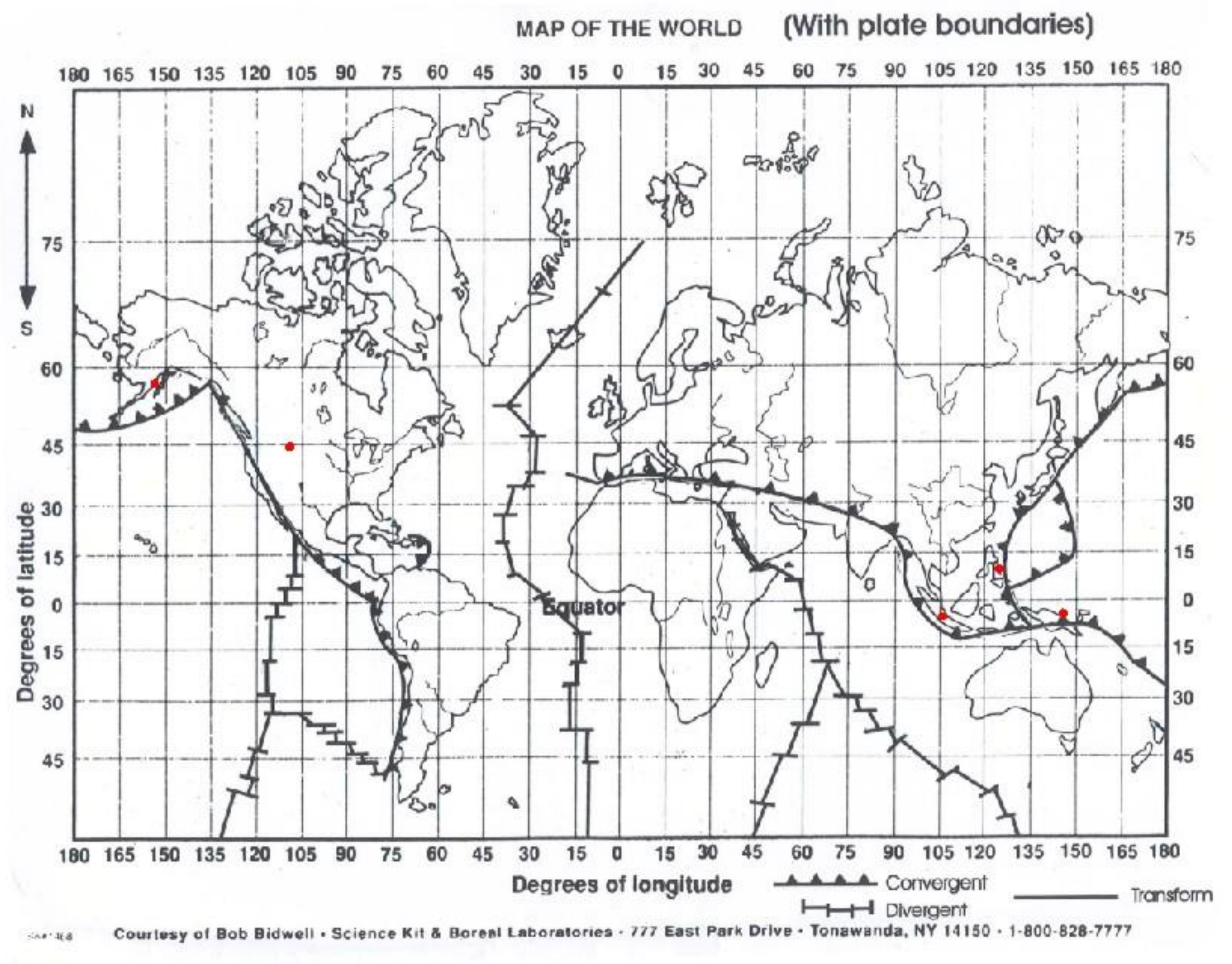

MAP OF THE WORLD (With plate boundaries)
180 165 150 135 120 105 90 75 60 45 30 15 0 15 30 45 60 75 90 105 120 135 150 165 180
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45
Degrees of latitude
Equator
Degrees of longitude
Convergent
Divergent
Transform
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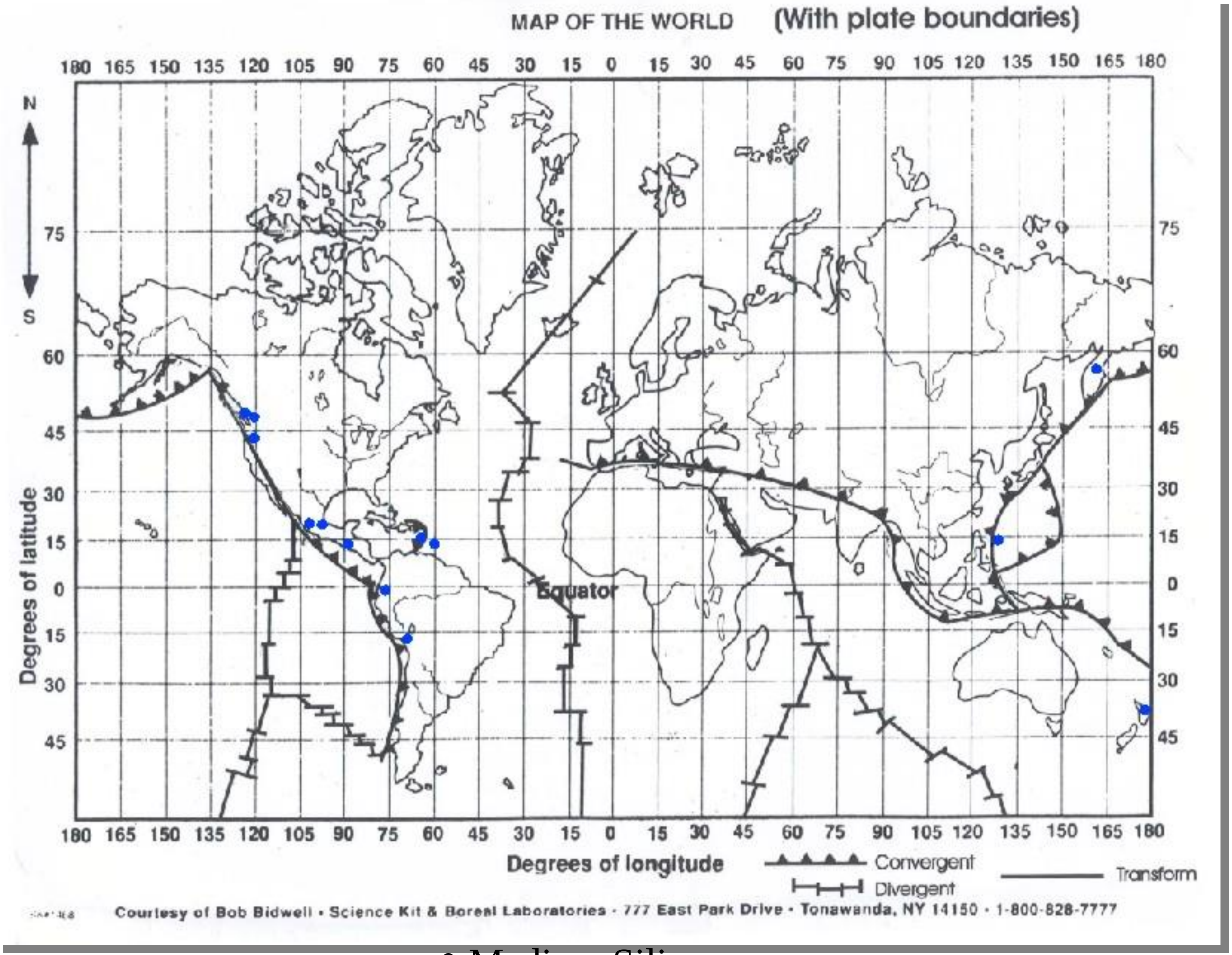
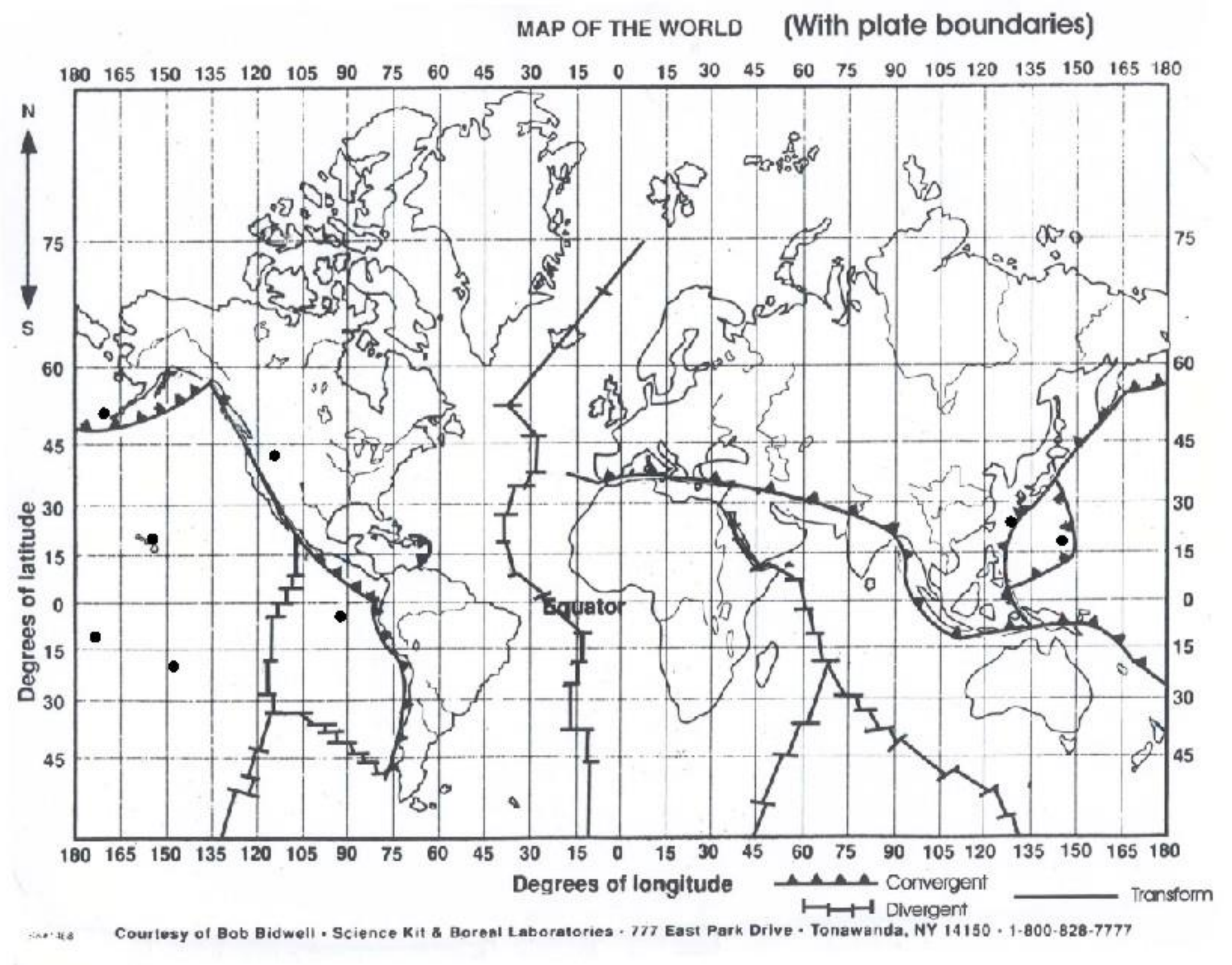
- High Silica



• Medium Silica


MAP OF THE WORLD (With plate boundaries)
180 165 150 135 120 105 90 75 60 45 30 15 0 15 30 45 60 75 90 105 120 135 150 165 180
N
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Degrees of latitude
Equator
Degrees of longitude
Convergent
Divergent
Transform
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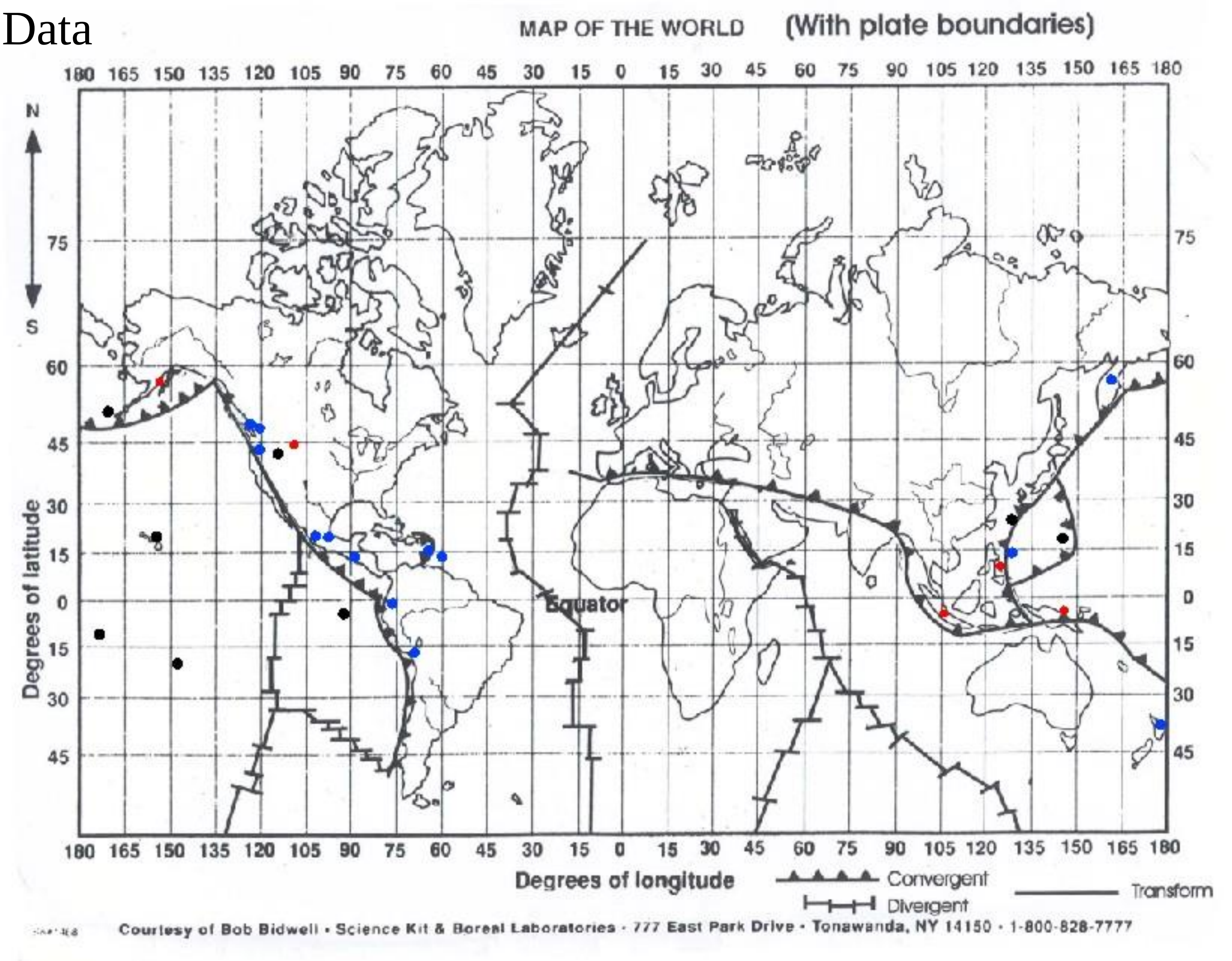
• Low Silica

Data



High Silica   Medium Silica   Low Silica

Question 1

- Which two volcanoes have the greatest percentage of silica in their magma?

- Katmai and Yellowstone have the highest percentage of silica in their magma.

Volcano	Latitude	Longitude	Silica
Katmai	58^{o}N	155^{o}W	76.9 %
Yellowstone	45^{o}N	111^{o}W	75.5%

Questions 2 and 3

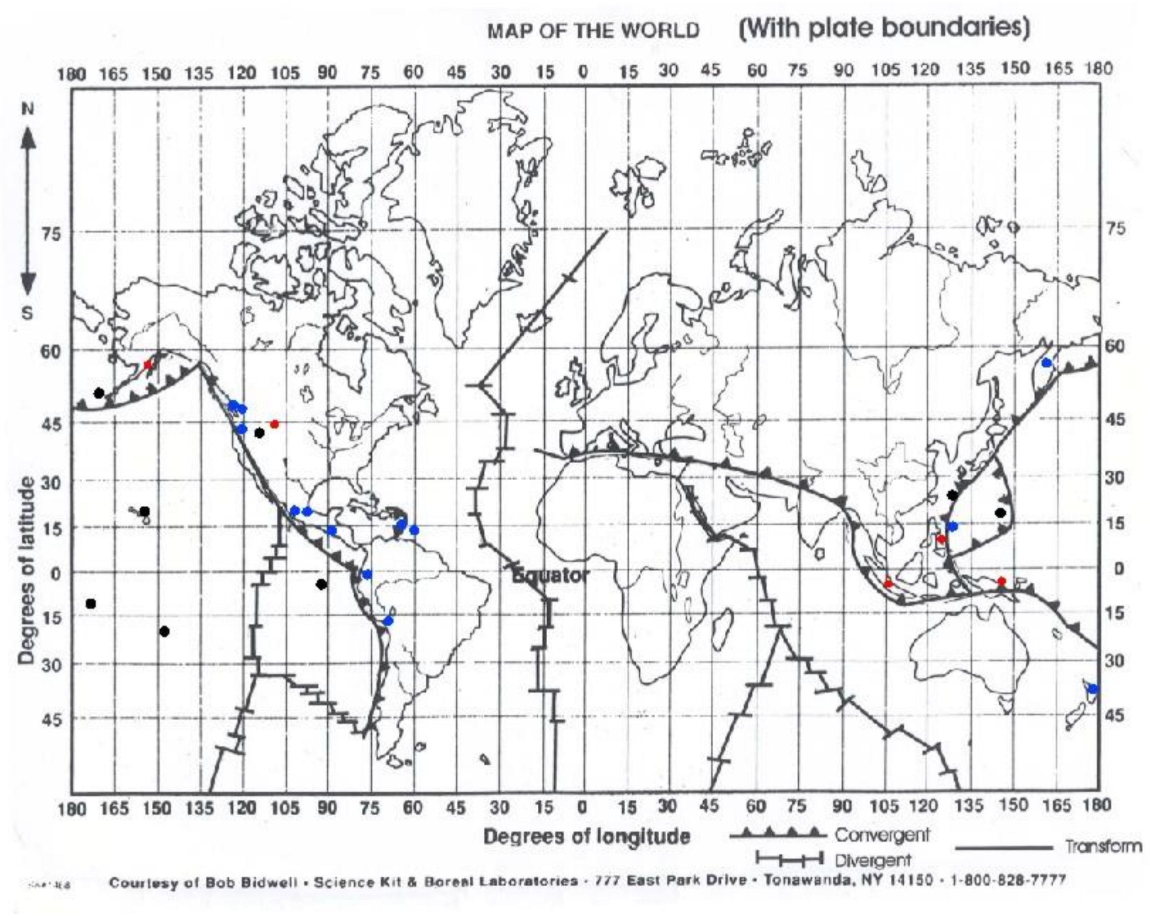
2. With regard to plate tectonics, describe the type of plate boundary that tends to be associated with volcanoes that have a high silica content?
   - Convergent (subduction)

3. Which two volcanoes have the lowest silica content?
   - Tahiti and American Samoa

Question 4

Where do volcanoes that are low in silica occur?

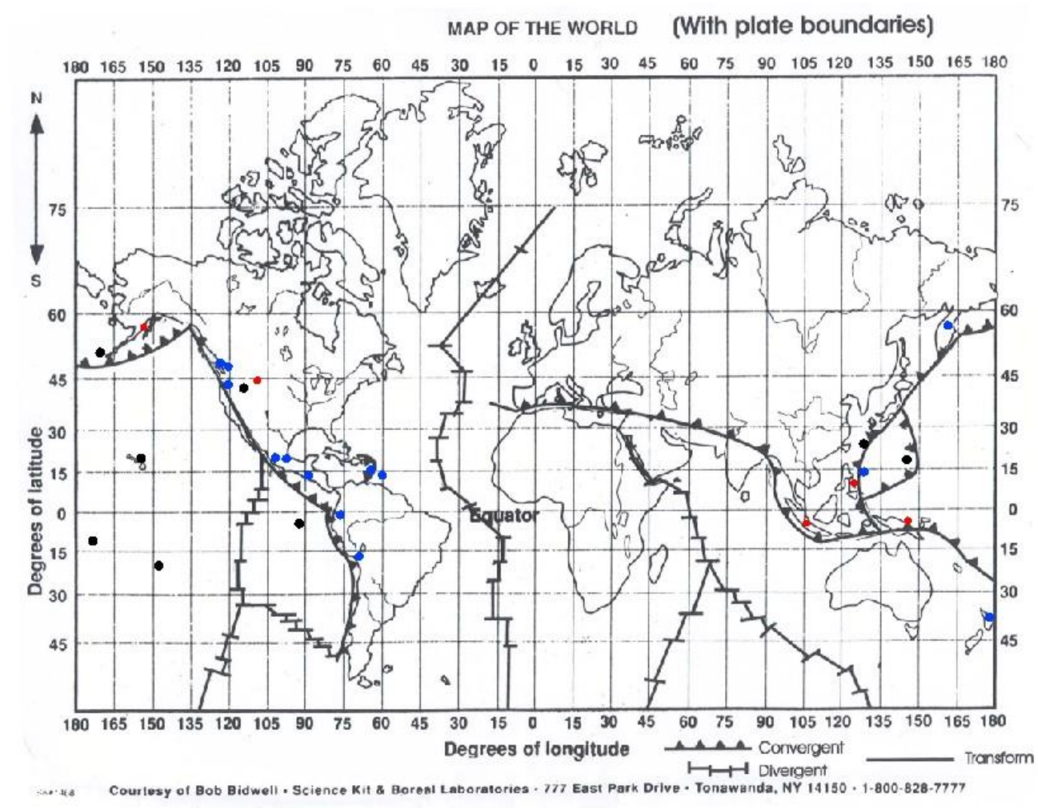
They tend to occur in ocean basins



Question 5

Explain why medium-level silica volcanoes tend to occur along the coasts of continents?

They tend to occur along the coasts of continents because as the magma rises through the crust it absorbs some silica from the granite that the continents are made of



Question 6

Look at the chemical analysis of two volcanic rocks. One from Hawaii and another from Yellowstone. What is the major component in both?

Location	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Other	Total
Obsidian Cliff	75.50	13.25	1.02	0.91	0.07	0.90	4.76	2.85	0.74	100.00
Basalt	49.58	13.19	2.40	9.49	8.30	10.69	2.25	0.55	3.55	100.00

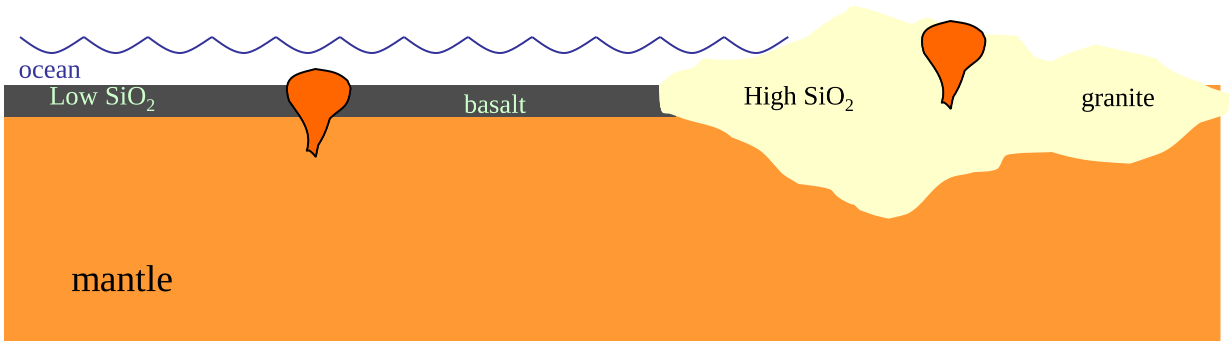
- Silica (SiO_2)

Question 7

Both, obsidian and basalt, are extrusive igneous rocks. Why do you think the silica content differs so much from each other?

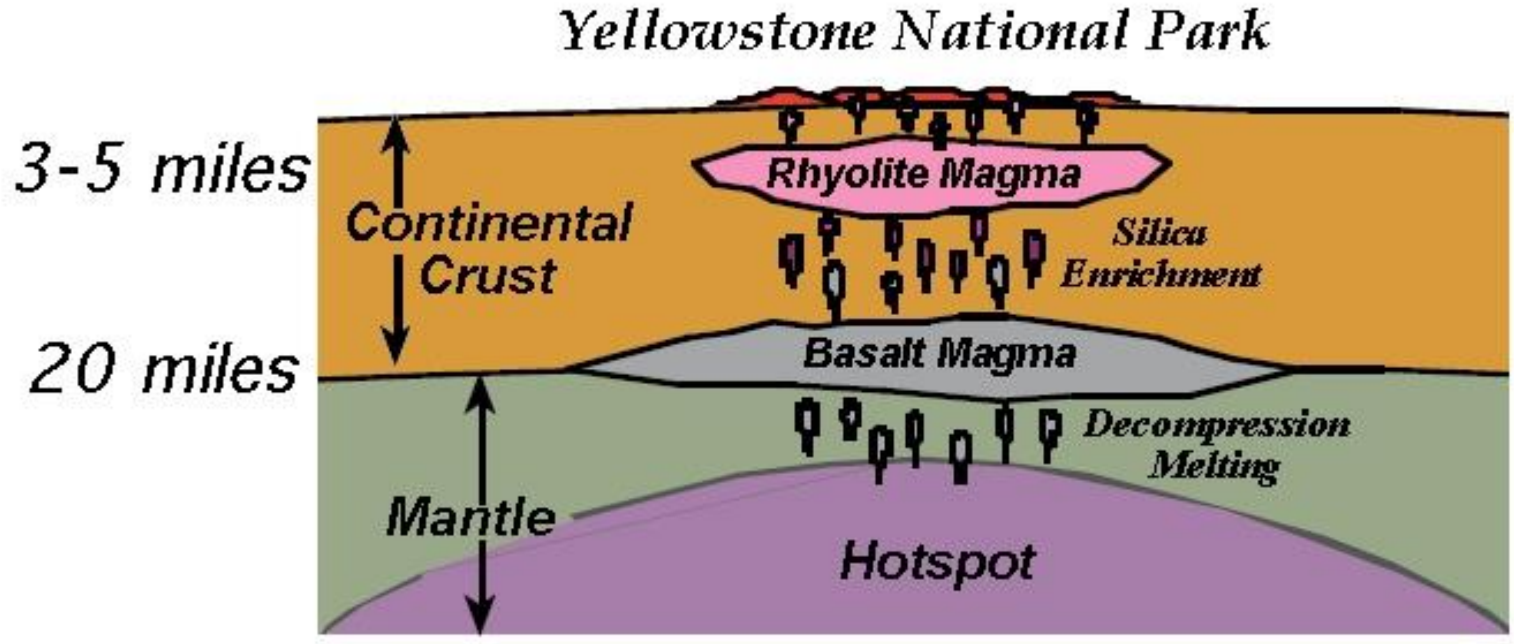
Answer 7

The rocks differ in silica because the magma in Hawaii comes up through the ocean floor which is made of basalt (low in silica) while the magma coming up beneath Yellowstone absorbs silica as it melts its way through the continent (high in silica).



CONCLUSION

- Volcanoes which are high in silica tend to be associated with continents near subduction zones while volcanoes low in silica are found on the ocean floor.
- Magma assimilation and differentiation explains the difference in the composition of the volcanoes.



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Teacher Resources

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Welcome to the Teacher Resources section of Windows to the Universe, where we try to collect resources of our own, as well as of partner organizations that we think you will be interested in. We regularly update this section with information about our web seminars, workshops and new classroom activities. We also provide links, below to several of our key resources, including motivational quotes, Earth science literacy frameworks, materials from our professional development workshops, our Teacher Opportunities calendar (Members Only), and a link to our free monthly Earth and Space Science Educator Newsletter. Windows to the Universe and its educational resources have been reviewed by NASA's Office of Space Sciences and Earth Science Enterprise, receiving exemplary status.

Teachers - Become an Educator Member of Windows to the Universe for special benefits and opportunities, including information about valuable special offers for classroom grants, professional development with travel and/or stipends, research grants, and more!

Windows to the Universe is now offering on-site professional development workshops for teachers. Find out more about this opportunity here. Information about our upcoming workshops and events at the NSTA conference in Indianapolis is available under 2012 on our Teacher Resources/Workshops page.

Scientists are concerned that melting Arctic sea ice will increase the amount of fresh water in the Beaufort Gyre, which could spill out into the Atlantic and cause major climate shifts in North America and Western Europe. Our new lesson plan, The Case of the Leaky Gyre, explores the circulation in ocean gyres and the potential climate impacts. Watch the Changing Planet: Fresh Water in the Arctic video.

Courtesy of Jack Cook, WHOI (Woods Hole Oceanographic Institute)

Upcoming Earth & Space Science Historical Events

10/18 Thomas Edison,an American inventor, died on this date in 1931 Details

10/19 Ernest Rutherford,a British physicist and Nobel prize winner, died on this date in 1937 Details

10/24 Tycho Brahe,a Danish astronomer, died on this date in 1601 Details

11/3 On this date in 1957 satellite Sputnik 2 that carried a dog, named Laika, was launched into space Details

Earth and Space Science History Calendar

Upcoming Events and Opportunities

10/12 Earth Science Week 2014: 'Earth's Connected Systems' Details

Events and Opportunities Calendar

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Teachers participate in hands-on activities at a workshop at the NSTA National Conference on Science Education.
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Windows to the Universe Earth and Space Science Educator Newsletter Central

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Please also visit our Teacher Resources section for classroom activities, information from our recent workshops and presentations, and other useful information.

October 2014 Newsletter

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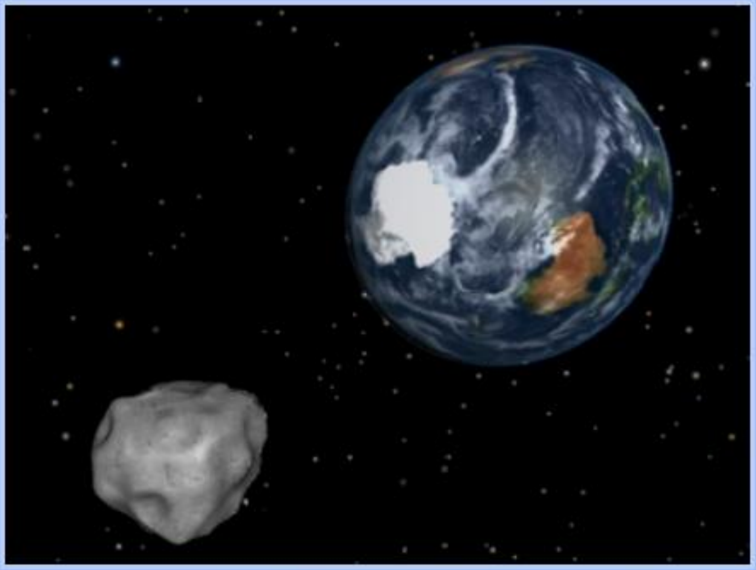

A near-Earth asteroid - named 2012 DA14 by astronomers – passed within 17,200 miles from Earth on February 15, 2013. On closest approach at about 1:25 p.m. CST on February 15, although it was within the orbit of the Moon and even geosynchronous satellites, it didn't strike Earth! Find out more from NASA! Fragments of a meteorite hit Chelyabinsk, Russia on 2/15/2013 injuring over 500. Learn about meteors and meteorites.

NASA/JPL-CalTech

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2 of 8 matches

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Development of the NESTA

Welcome to NESTA

Schedule of NESTA/W2U workshops at the Fall NSTA Conferences

Our Space Science and Astronomy Education web seminar series is now complete. All web seminars have been recorded and are available for free on the Windows to the Universe Web Seminar page. Powerpoints presented in the web seminars are available for download by Windows to the Universe Educators on this same page.

The National Earth Science Teachers Association is a nonprofit 501(c)(3) educational organization, founded in 1985, whose mission is to facilitate and advance excellence in Earth and Space Science education. NESTA's purpose is the advancement, stimulation, extension, improvement, and coordination of Earth Science education at all educational levels. NESTA is an organization made up of and governed by classroom teachers, and extends its influence through association with other professional societies and organizations. We always welcome new members - JOIN NESTA today!

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Upcoming Events

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Earth Science Week 2014: 'Earth's Connected Systems'

10/12/2014 - 8:00am

STANYS Earth Science Breakfast

11/04/2014 - 7:00am

Harnessing the Power of Earth System Science for Developing Science Practices and Crosscutting Concepts

10/17/2014 - 9:30am

Harnessing the Power of Earth System Science for Developing Science Practices and Crosscutting Concepts

11/07/2014 - 8:00am

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Earth2Class (Earth to Class)

E2C is a unique science/math/technology resource for K-12 teachers, students, the general public, and geoscientists. It is a collaboration among researchers and an Earth Sc
the Lamont-Doherty Earth Observatory of Columbia University; technology integration specialists from Colégio Bandeirantes, São Paulo, Brasil; and classroom teachers from
Jersey, and elsewhere.

E2C centers around "Saturday Workshops for Educators" held at Columbia's Lamont Campus in Palisades N.Y. One key feature to E2C is involvement of LDEO scientists. Th
through workshops, web site postings, and e-mail allow teachers and students access to cutting-edge research which can be used to develop learning activities directly linke
problems," and provide scientists with an effective format to disseminate their discoveries more broadly. Since 1998, we have provided more than 120 Workshops featuring
scientists.

2014 – 2015 Earth2Class Workshops

"Trees, Climate, and Societal Relevance: A Case Study in Mongolia" with Caroline Leland and Mukund Palat Rao (Sep 2014)

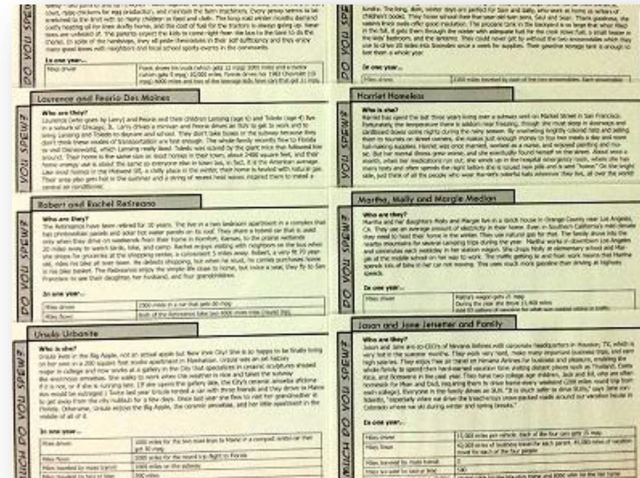
"How Have Glaciers Behaved in Patagonia in the Past?" with Michael Kaplan (Oct 2014)

"How does the land affect climate?" with Alexis Berg (10 Jan 2015)

Questions?

Classroom Activity Kits
Available at the NESTA Trading Post

Glaciers: Then and Now



CO2: How Much Do You Spew?

Traveling Nitrogen

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Today (All events in this room)

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- 9:30 – 10:30 – Earth Science Rocks! Using Earth Science Activities to Engage Students as Scientists
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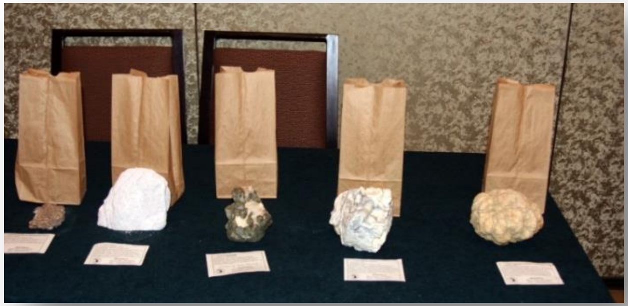

Please join

us at the

Rock and Mineral Raffle, 3:30 – 4:30 pm

This room, today!

Rocks & Mineral

Fossils & Sand

Kits, and many

other goodies!