Lava Flows and Volcanos

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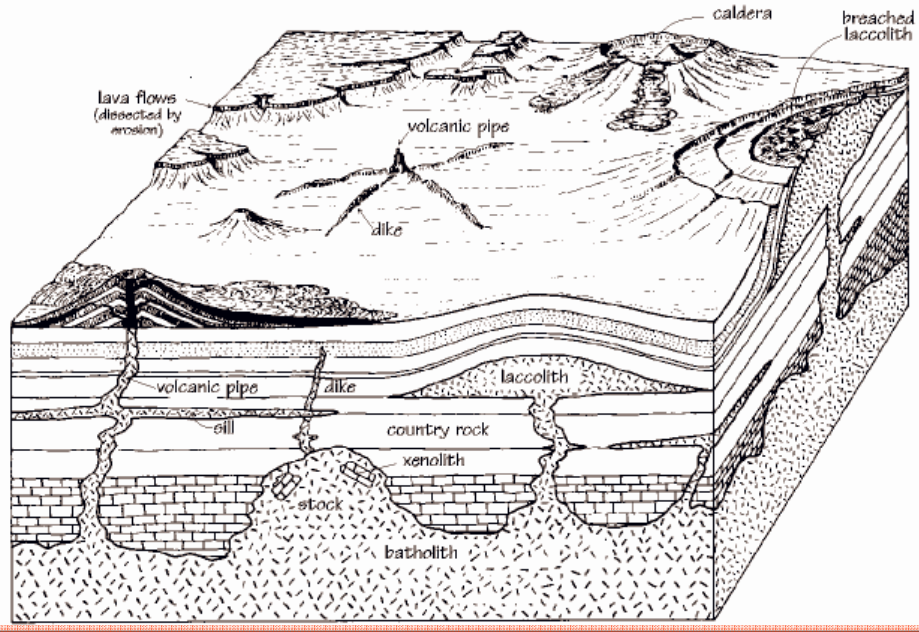
Fall, 2005

Intrusive and Extrusive Igneous Rocks

P 93



Intrusives *Igneous rock bodies emplaced (intruded) within (below) the earth's surface.*

Extrusives *Igneous rock bodies extruded onto the earth's surface = lava flows and pyroclastics.*

Intrusive Igneous Bodies

Discordant

Batholith *A plutonic mass with more than 40 sq mile surface exposure and no known floor*

Stock *A plutonic mass with less than 40 sq mile surface exposure otherwise like a batholith*

Dike *A tabular (planar, flat) intrusion that cuts across the bedding or foliation.*

Volcanic Pipe *A vertical conduit that feeds magma to a volcano*

Concordant

Sill *A tabular (planar, flat) intrusion that runs parallel to the bedding or foliation.*

Laccolith *Intrusion with a flat floor, convex upper surface, and roughly circular in plan*

EXTRUSIVE IGNEOUS ROCKS: LAVA FLOWS AND PYROCLASTICS

Lynn S. Fichter
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James Madison University

Fall, 2004 – Version 1

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Lava Type
Extrusive Igneous Rocks

Kind of Lava	Typical Magma	Descriptive Features
Pahoehoe		
Aa (Ah Ah)		
Columnar		
Pillow		
Blocky		

Pahoehoe – Ropey Lava

http://www.bishopmuseum.org/exhibits/pastExhibits/2001/xtreme/images/pahoehoe.jpg

Pahoehoe – Ropey Lava

HTTP://VOLCANO.UND.NODAK.EDU/VWDOCS/VWLESSONS/LAVA_PICS/PAHOEHOE.JPG

Pahoehoe – Ropey Lava

HTTP:□□VOLCANO.UND.NODAK.EDU□VWDOCS□VWLESSONS□LAVA.HTML

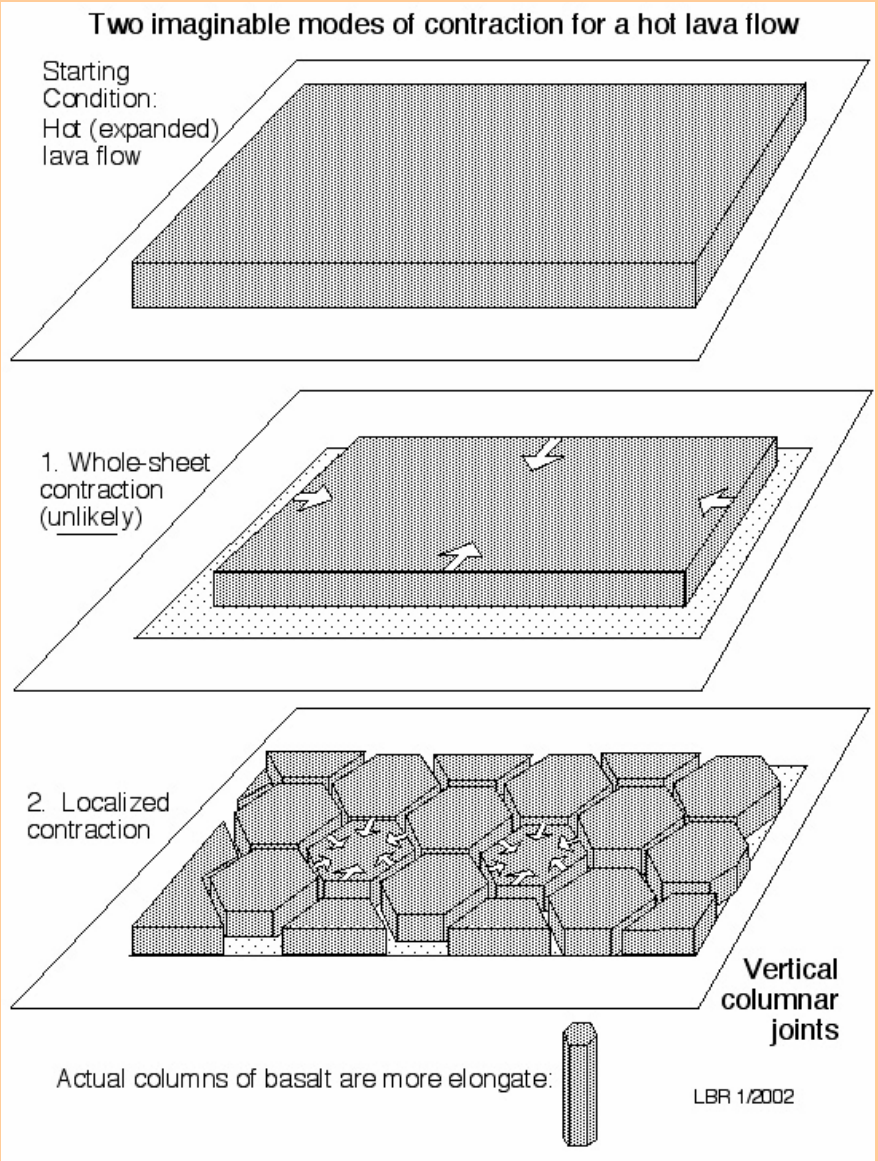
Aa lava

http://www.ciw.edu/akir/Images/Earth/Aa.gif

Aa lava

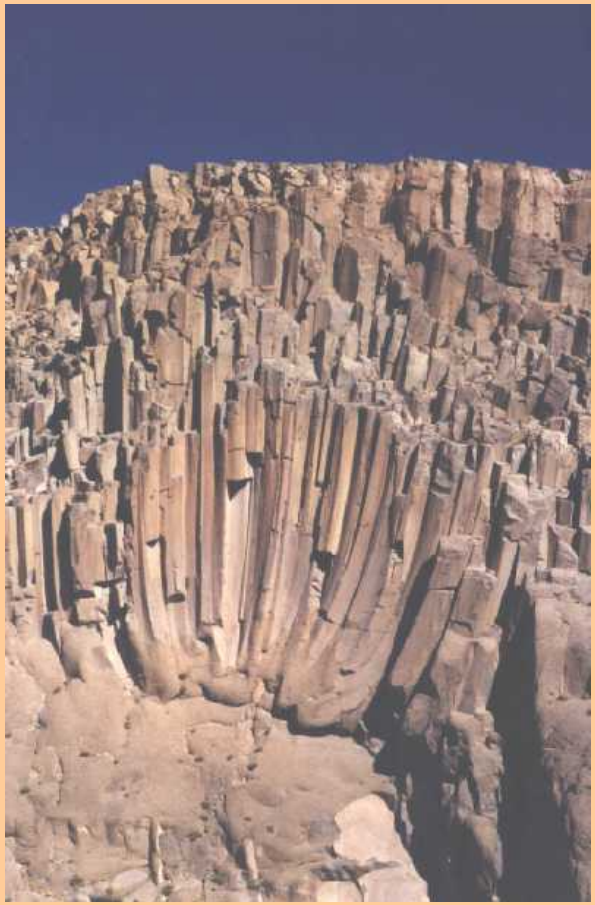
http://volcanoes.usgs.gov/Imgs/Jpg/Kilauea/30212265-054_large.jpg

Columnar lava



http://www.gly.uga.edu/railsback/GeologicalDiagrams1.html

Columnar lava



http://www.eps.mcgill.ca/groups/volcano/ben/www/images/Bishops%20tuff%20columnar%20joints.jpg

Columnar lava

http://ijolite.geology.uiuc.edu/NatlParks/Yosemite/DevilsPP.jpg

Columnar lava

http://ijolite.geology.uiuc.edu/NatlParks/Yosemite/Yosemite1.html

http://ffden-2.phys.uaf.edu/home.home.dir/iceland_home/images/converted/1.july.2002/P7010139.jpg

Columnar lava

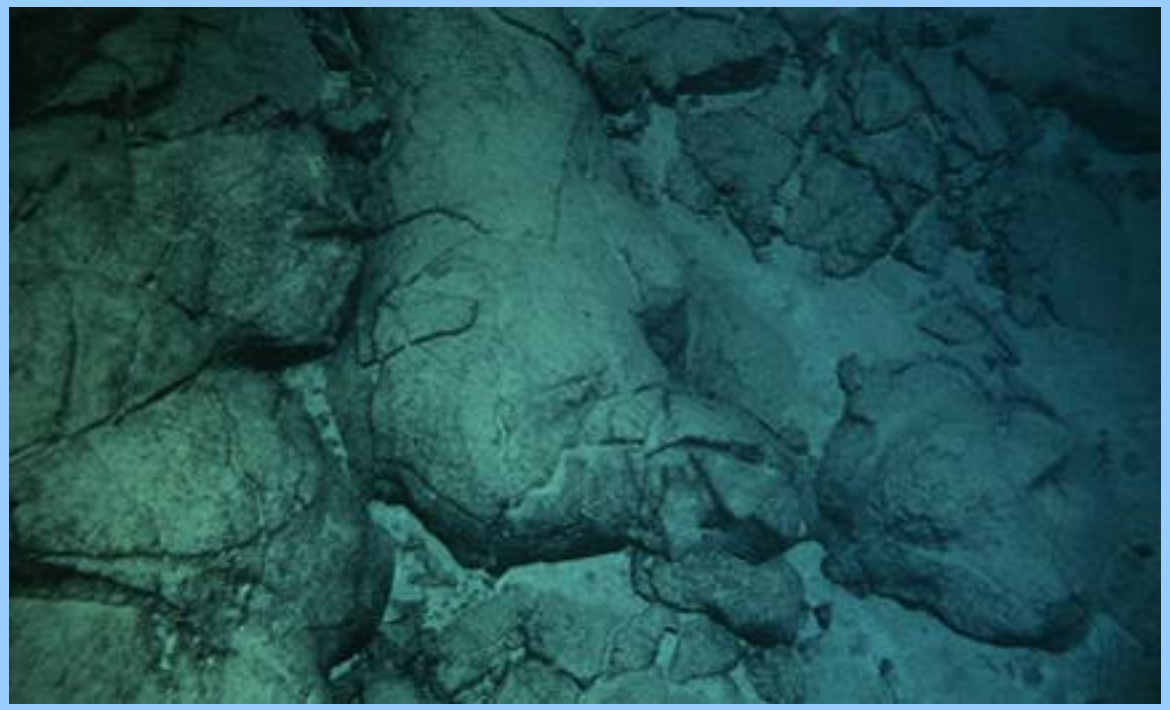
http://www.sjordi.com/pictures/usa/bigdeviltower011.jpg

HTTP://EPSC.WUSTL.EDU/~RBUCHWALDT/CENOZOIC.HTML

Pillow lava

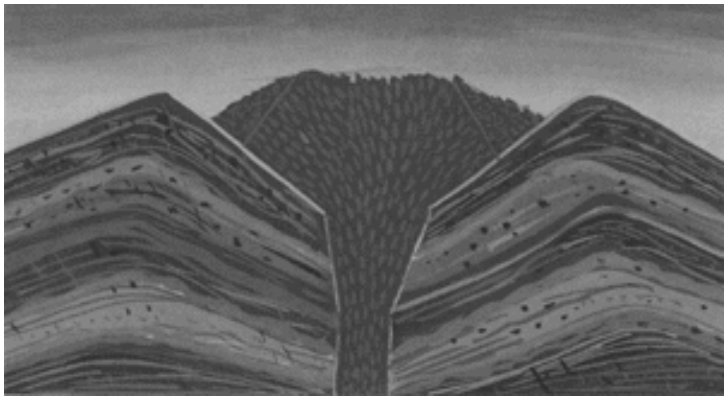
HTTP://VOLCANO.UND.NODAK.EDU/VWDOCS/VWLESSONS/LAVA_PICS/TRIBBLE.JPG

Pillow lava



HTTP://VOLCANO.UND.NODAK.EDU/VWDOCS/VWLESSONS/LAVA_PICS/PILLOWS.JPG

Blocky Lava



http://pubs.usgs.gov/gip/volc/fig18.gif

Blocky Lava

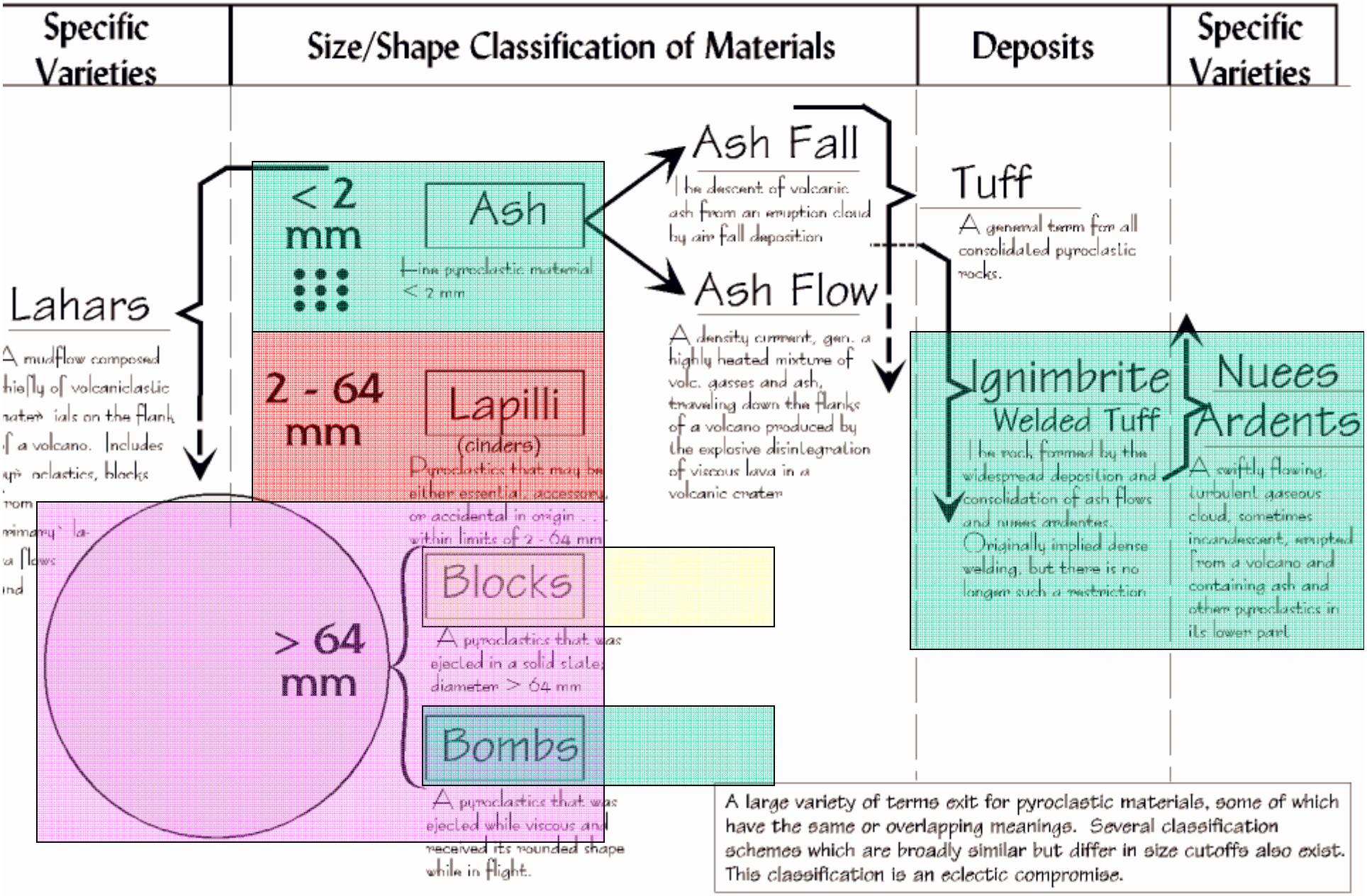
HTTP://WWW.EARTHSCAPE.ORG/TL/ROK01/DOME.GIF

Blocky Lava

HTTP://WWW.DECADEVOLCANO.NET/PHOTOS/SANTORINI/PICTURES_84/SANTORINI_8451.JPG

PYROCLASTICS

Pyroclastic Extrusive Igneous Rocks P 95



http://www.volcanolive.com/etna20.jpg

http://www.es.ucsc.edu/~jsr/eart10/Lectures/HTML/Images/pcflow.jpg

Volcanic Ash

Volcanic ash consists of rock, mineral, and volcanic glass fragments smaller than 2 mm (0.1 inch) in diameter, which is slightly larger than the size of a pinhead.

http://volcanoes.usgs.gov/Imgs/Jpg/Tephra/30410914-076_

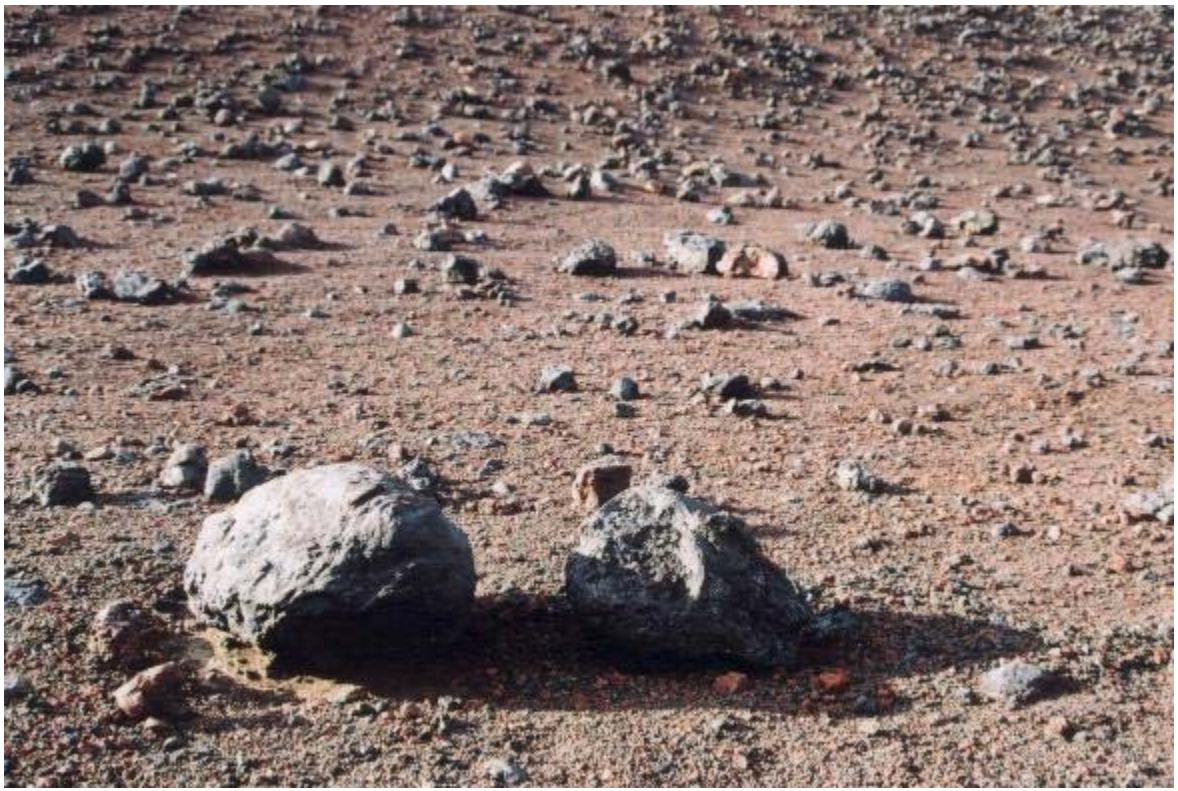
Volcanic Cinders (Lapilli)

HTTP://WWW.UWM.EDU/~TBOUNDY/ZOE/P1010022

Vesicular Basalt (block)

http://images.google.com/imgres?imgurl=http://csmres.jmu.edu/geollab/Fichter/IgnRx/HTMLimag/Basalt-Ves-2A1.25.JPG&imgrefurl=http://csmres.jmu.edu/geollab/Fichter/IgnRx/testimag/basalt-

Volcanic Bombs



Volcanic Bombs

HTTP:□□VOLCANOES.USGS.GOV□IMGS□JPG□PHOTO

Ash Fall

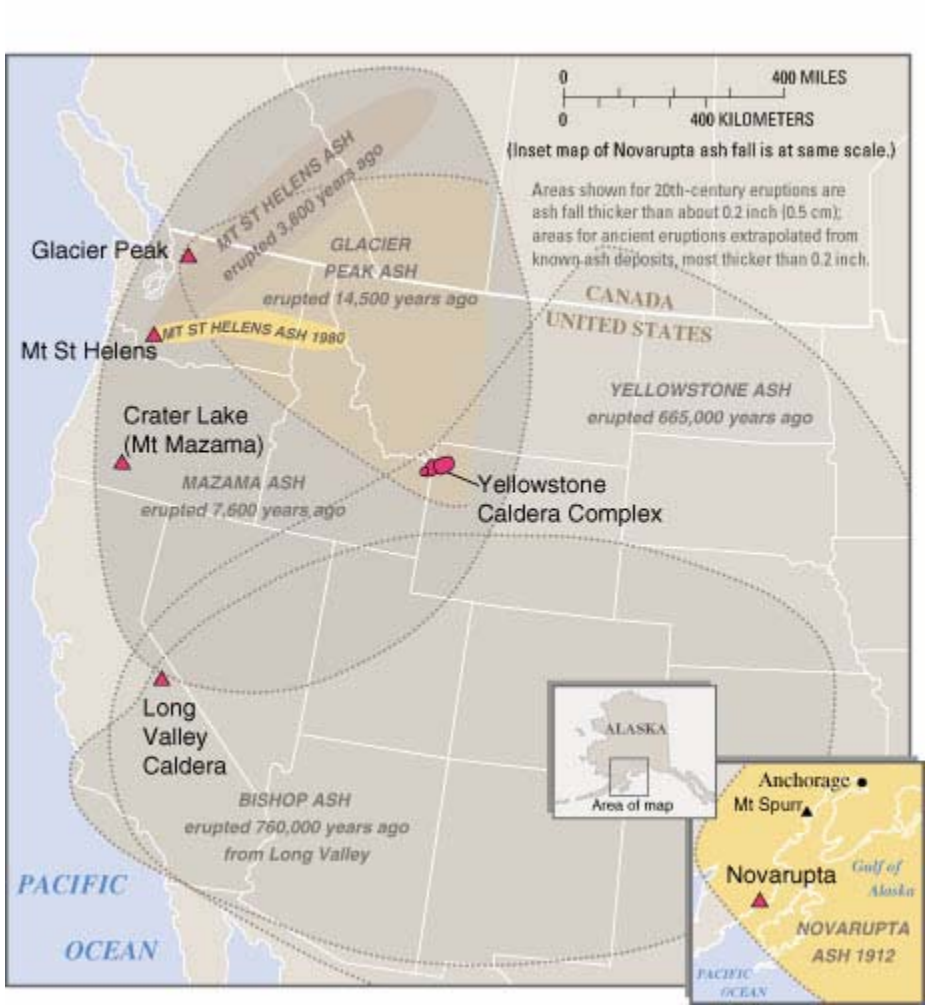
http://www.geo.mtu.edu/volcanoes/west.indies/soufriere/govt/images/072696/sego-04_02.jpg

Ash Fall

This surreal-looking photo shows an enormous cloud of volcanic ash approaching the small town of Ephrata, Washington, on the morning of May 18, 1980. The ominous cloud was from Mount St. Helens, 145 miles to the west.

HTTP://PUBS.USGS.GOV/FS/FS027-00/

Ash Fall Beds

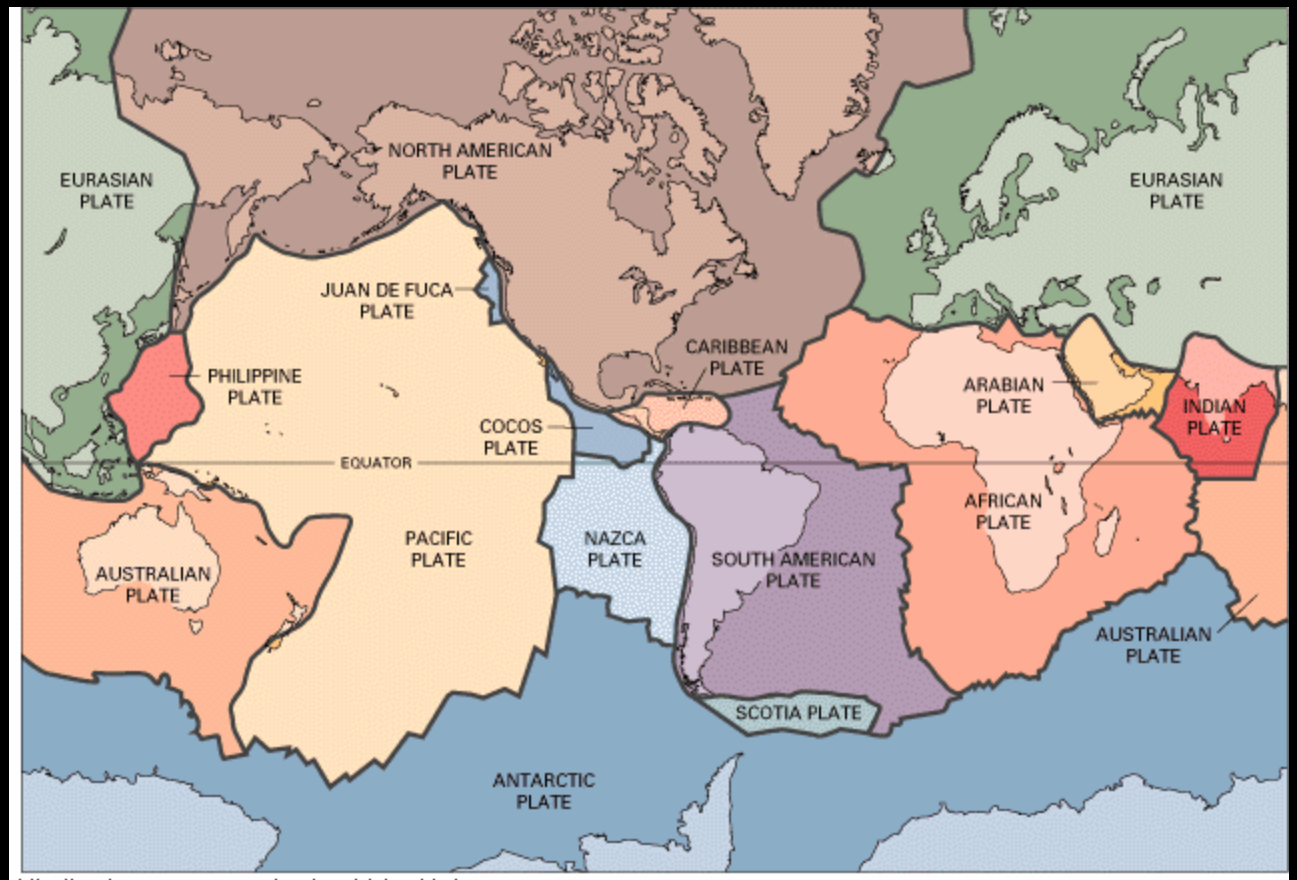


http://pubs.usgs.gov/fs/fs027-00/images/ashfalls2.jpg

VOLCANOES

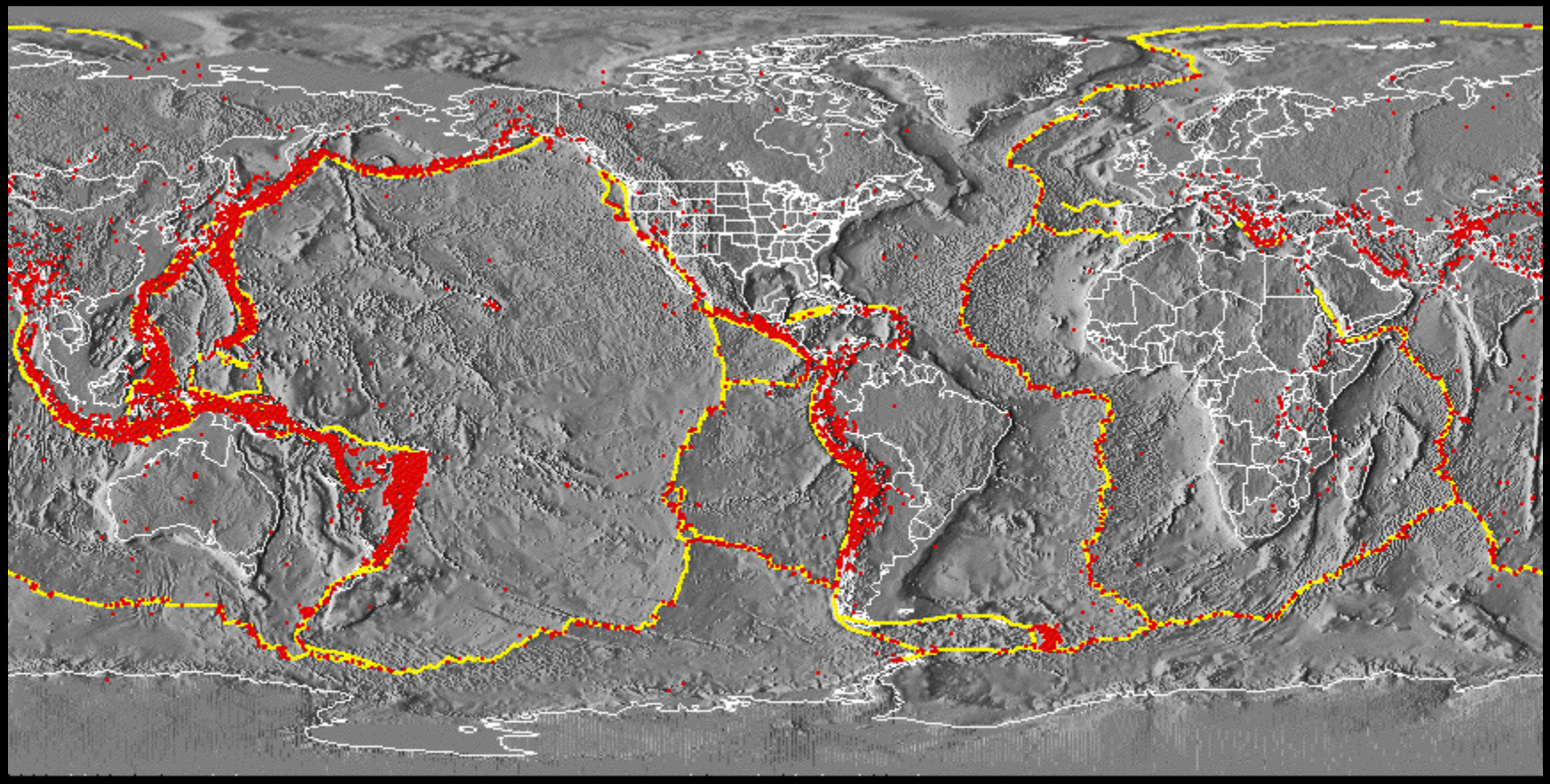
But first, a plate tectonic primer.

Earth's Tectonic Plates

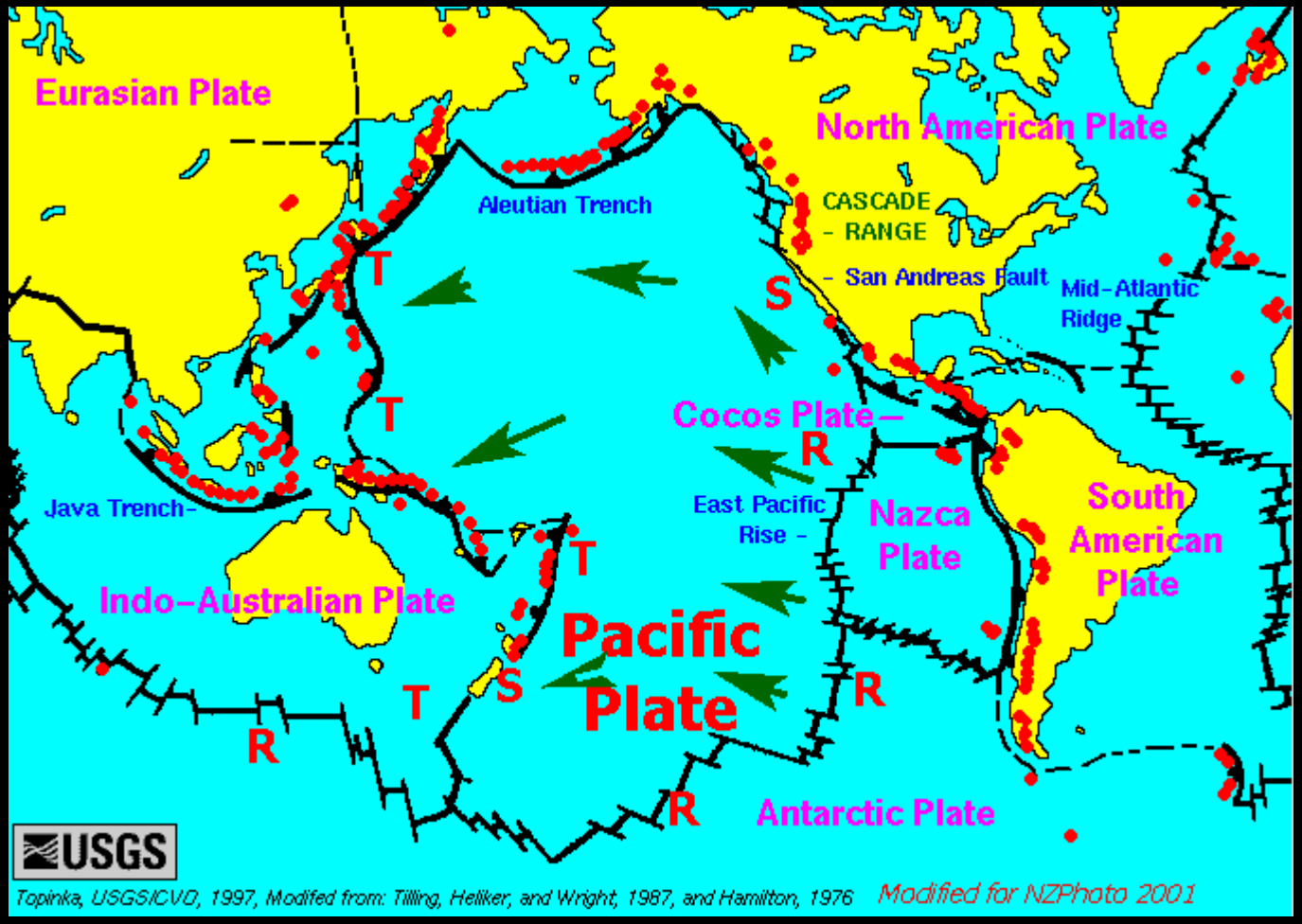


http://geology.er.usgs.gov/eastern/plates.html

Earthquake Activity Aligning With Tectonic Plate Boundaries



Volcanoes Associated with Plate Boundaries



Other Volcanoes Are Not Found at Plate Boundaries

Plates Move Across the Earth's Surface Driven by Convection Cells in the Mantle That Transfer Heat From the Interior To the Earth's Surface and then Space

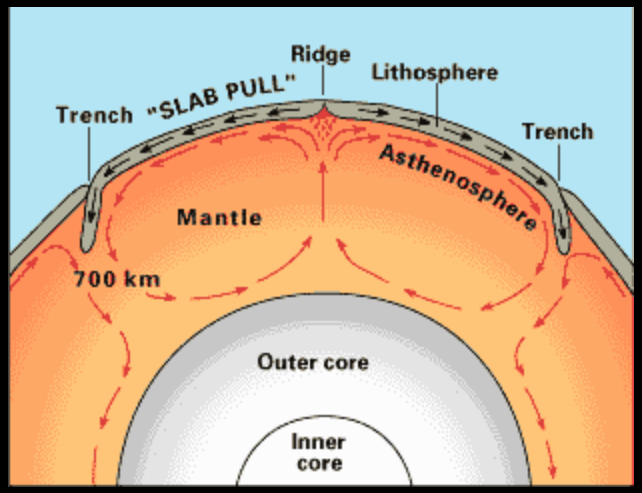
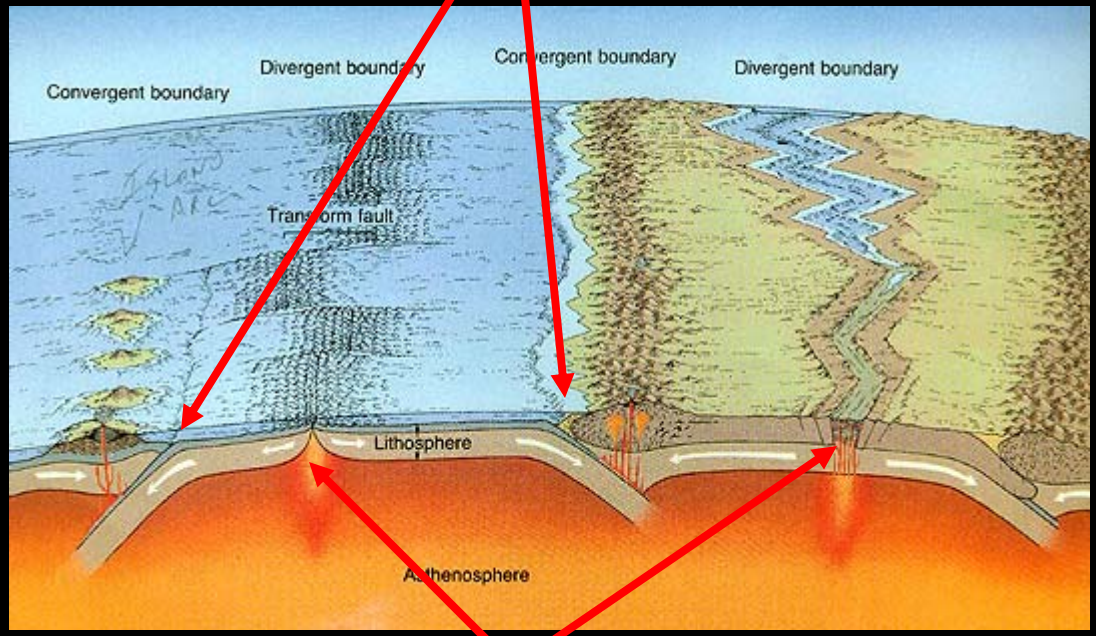


Plate Boundaries

Convergent

Plates come together forming a subduction zone

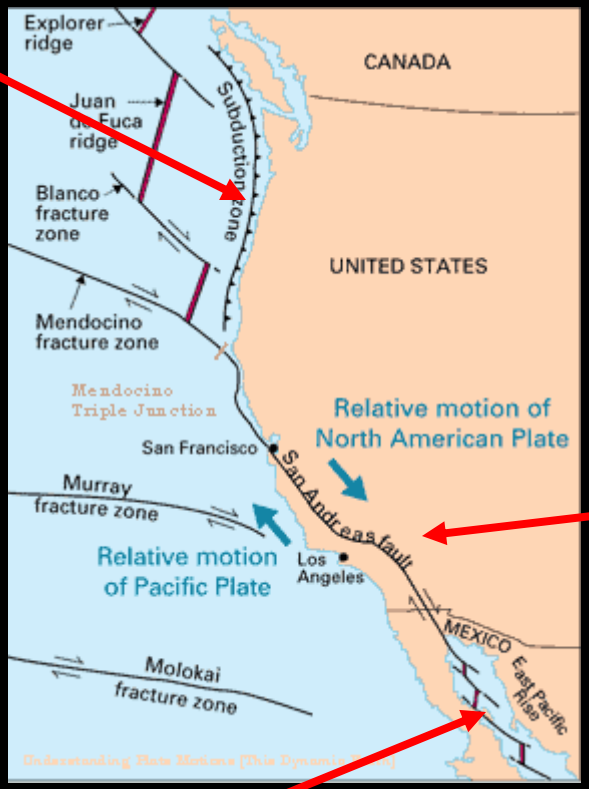


Divergent

Plates separate forming a fissure
That fills with magma

Plate Boundaries

Convergent



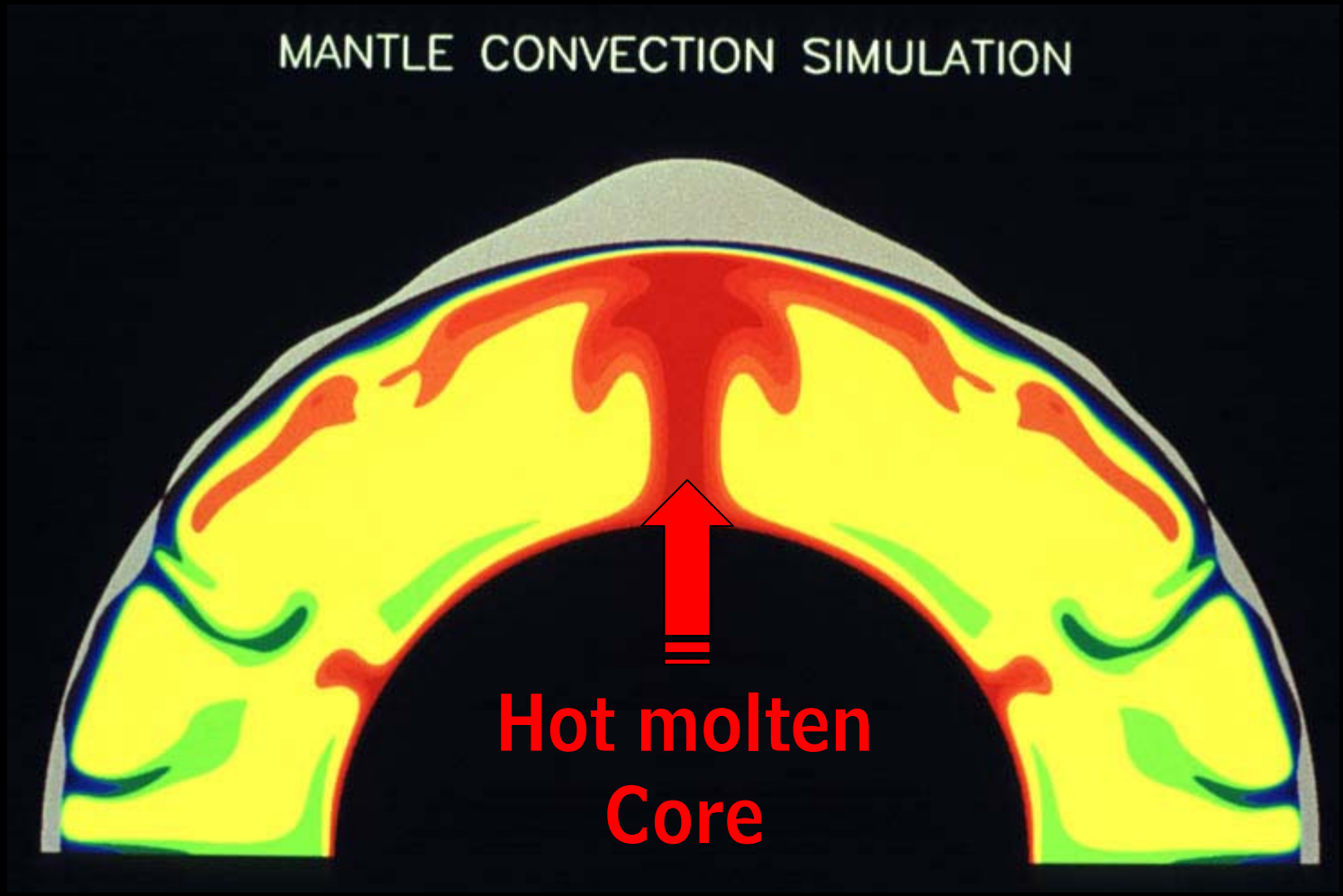
Transform

Plates slide past each other

Divergent

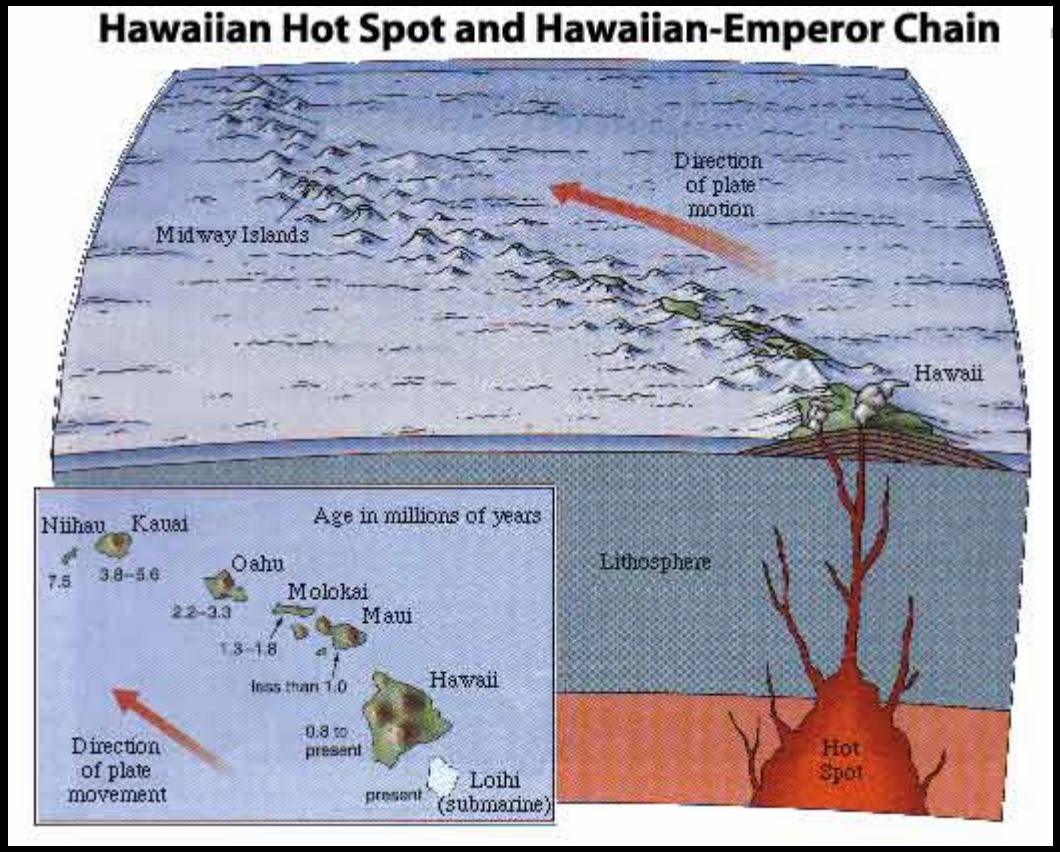
Volcanic Hot Spots

Igneous Activity Occurring Within Plates and Not At Plate Boundaries



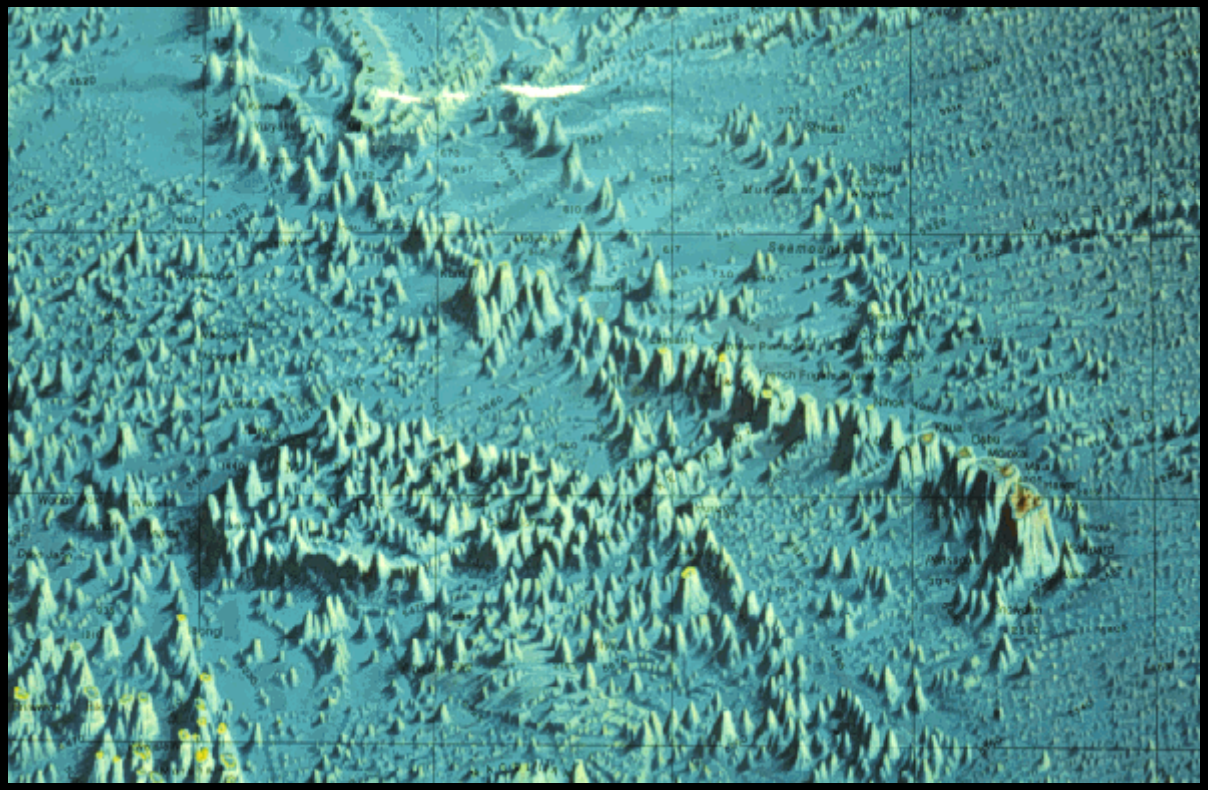
Volcanic Hot Spots

Igneous Activity Occurring Within Plates and Not At Plate Boundaries



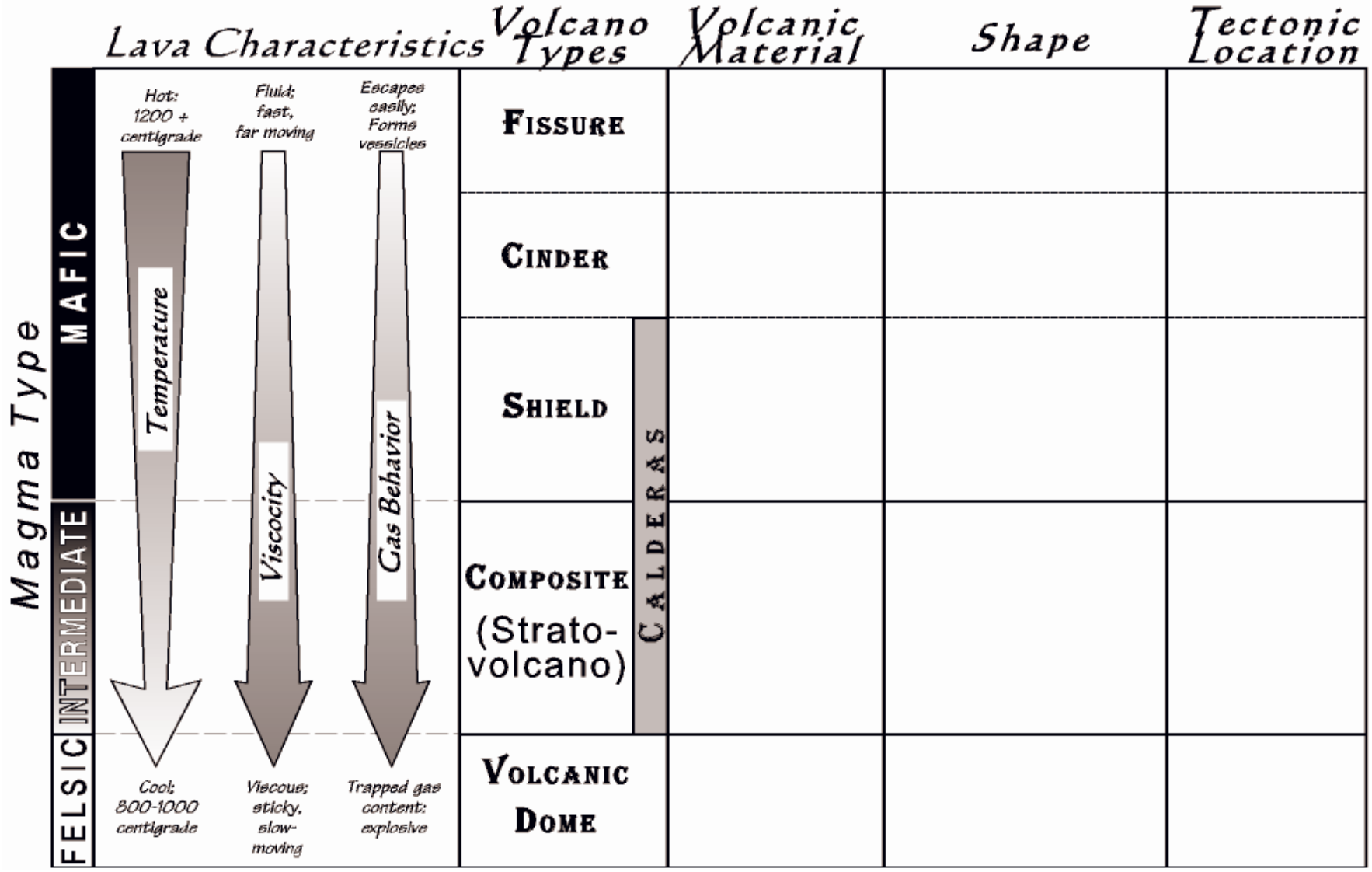
Volcanic Hot Spots

Igneous Activity Occurring Within Plates and Not At Plate Boundaries

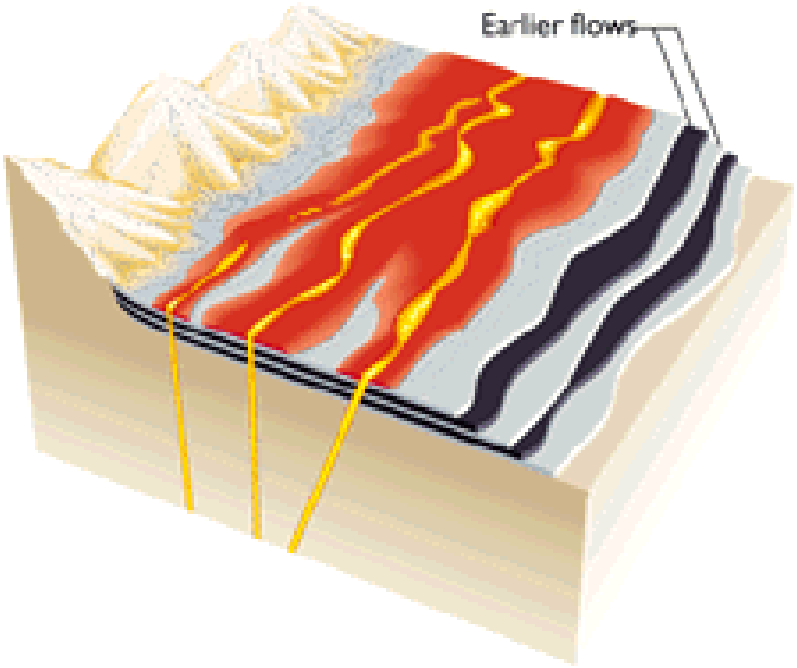


VOLCANOES

Eruptive Styles of Volcanoes

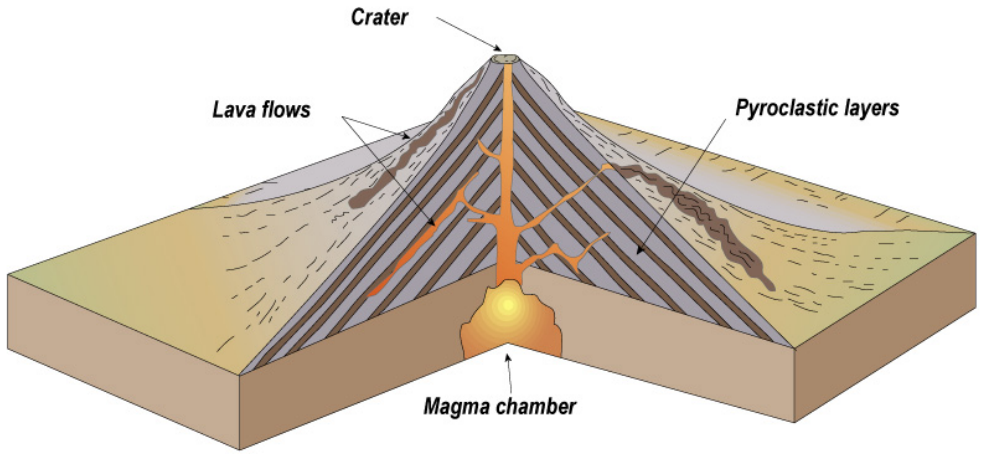


Extrusive Ingeous Rocks
Kinds of Volcanoes



http://www.whfreeman.com/UEOSG/CH05/EX05F.GIF

Fissure Volcano

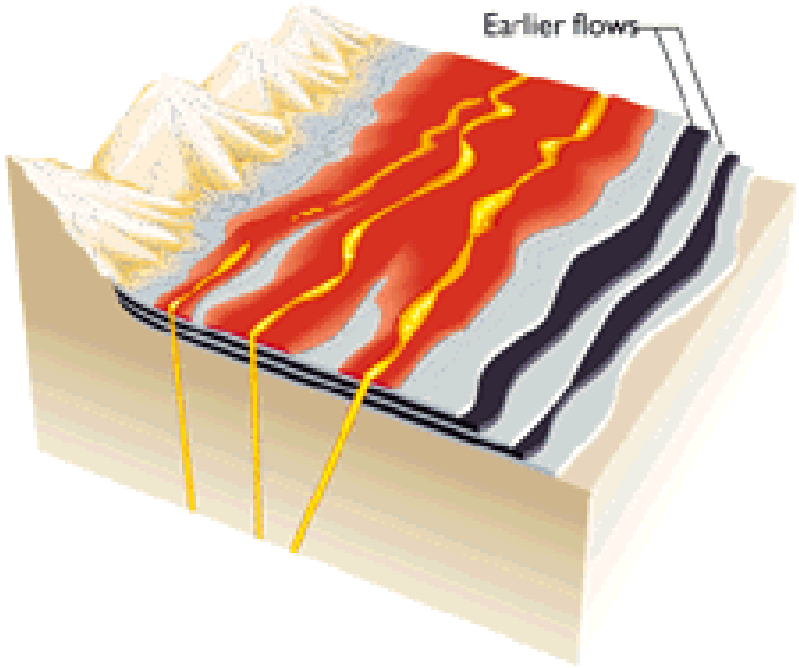


(d) Composite volcano

Pipe Volcano

Fissure Volcanoes

Divergent Plate Boundaries



HTTP://WWW.WHFREEMAN.COM/UEOSG/CH05/EX05F.GIF

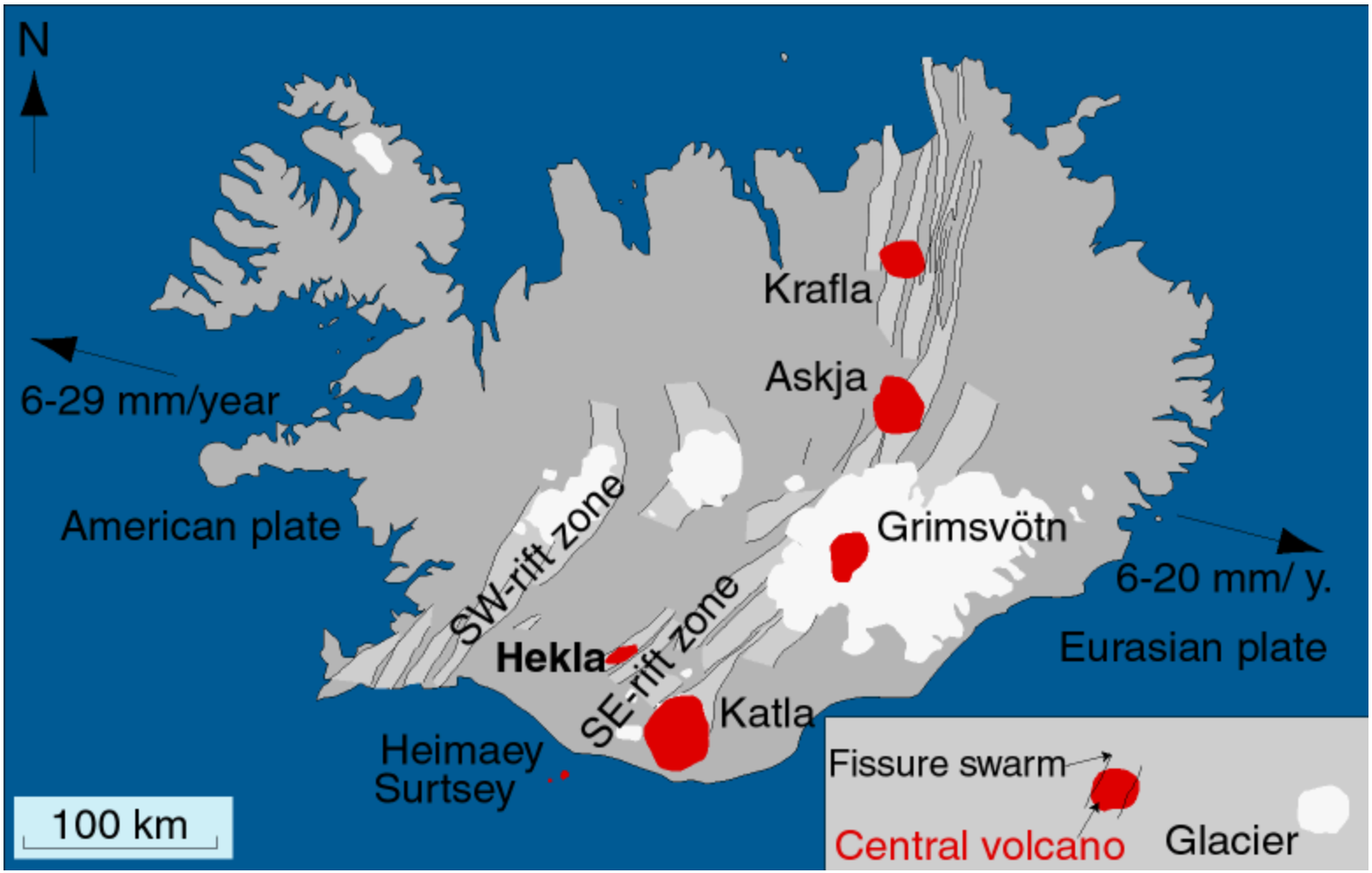
Fissure Volcano

HTTP:□□STATIC.HOWSTUFFWORKS.COM□GIF□VOLCANO
-FISSURE.JPG

Fissure Volcano

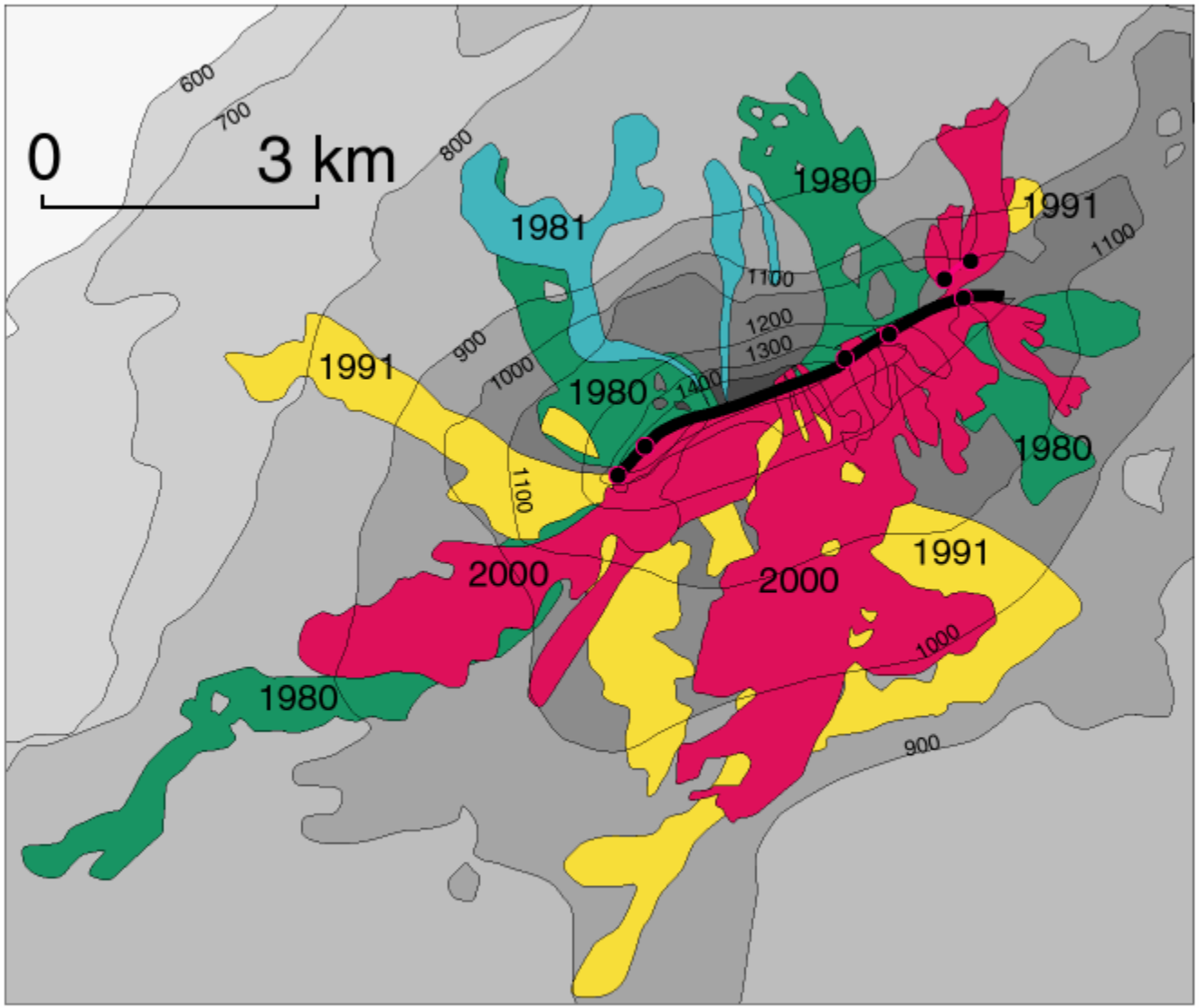
HTTP://VOLCANO.UND.NODAK.EDU/PICS/FISSURE.JPG

Iceland Fissure Volcanos
Along the Atlantic Divergent Plate Margin



http://www.decadevolcano.net/volcanoes/iceland/hekla.htm

Hekla Iceland Fissure Volcano

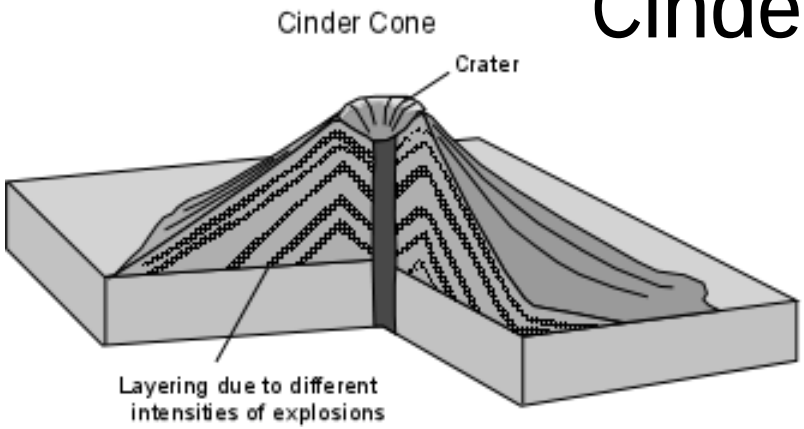


http://www.decadevolcano.net/volcanoes/iceland/hekla.htm

Iceland Fissure Volcano

http://www.decadevolcano.net/volcanoes/iceland/hekla.htm

Cinder Cones



http://earthsci.org/teacher/basicgeol/igneous/cindercone.gif

http://www.nps.gov/sucr/lava_flow/Sunset_Crater_Volcano_Lava_Flow_Trail_STOP_5.htm

Cinder Cone

http://www.csiro.au/images/mediaReleases/RabaulM

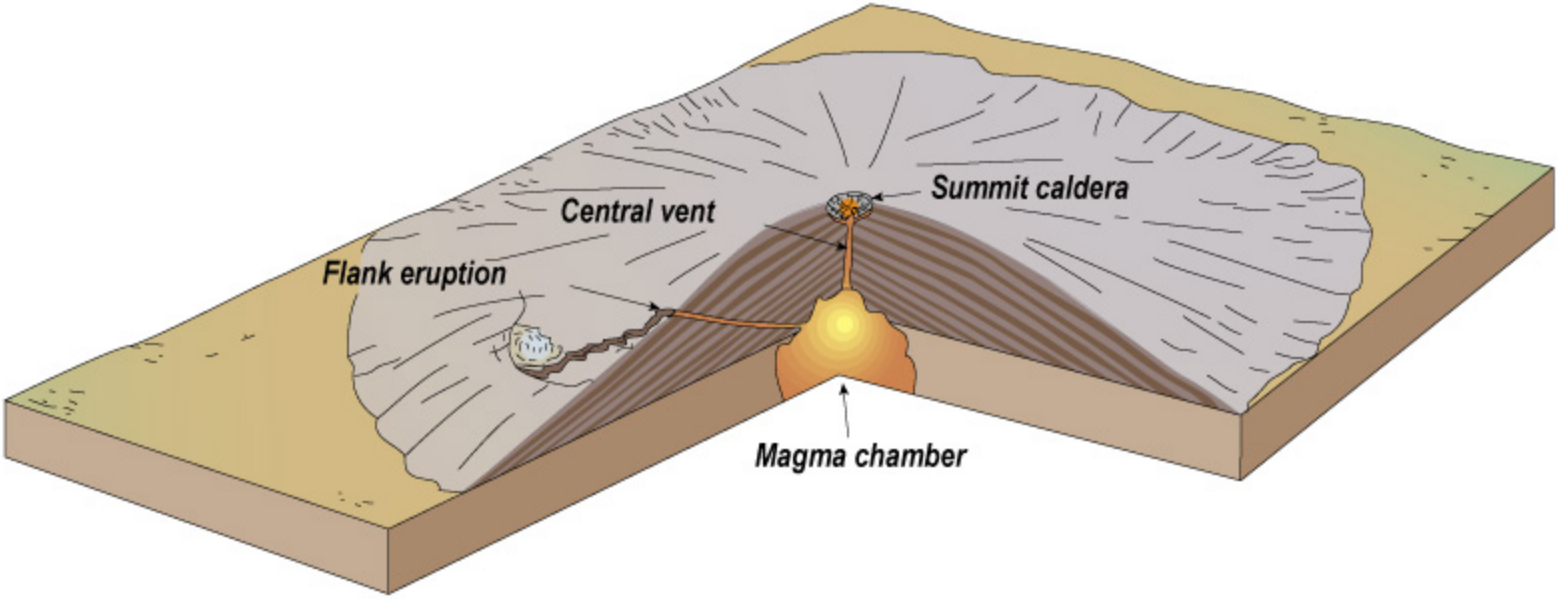
Cinder Cone

http://volcanoes.usgs.gov/Imgs/Jpg/Photoglossary/30424305-084_large.JPG

Cinder Cone

http://www.hawaiihighways.com/mauna-kea-cinder-cone-large.jpg

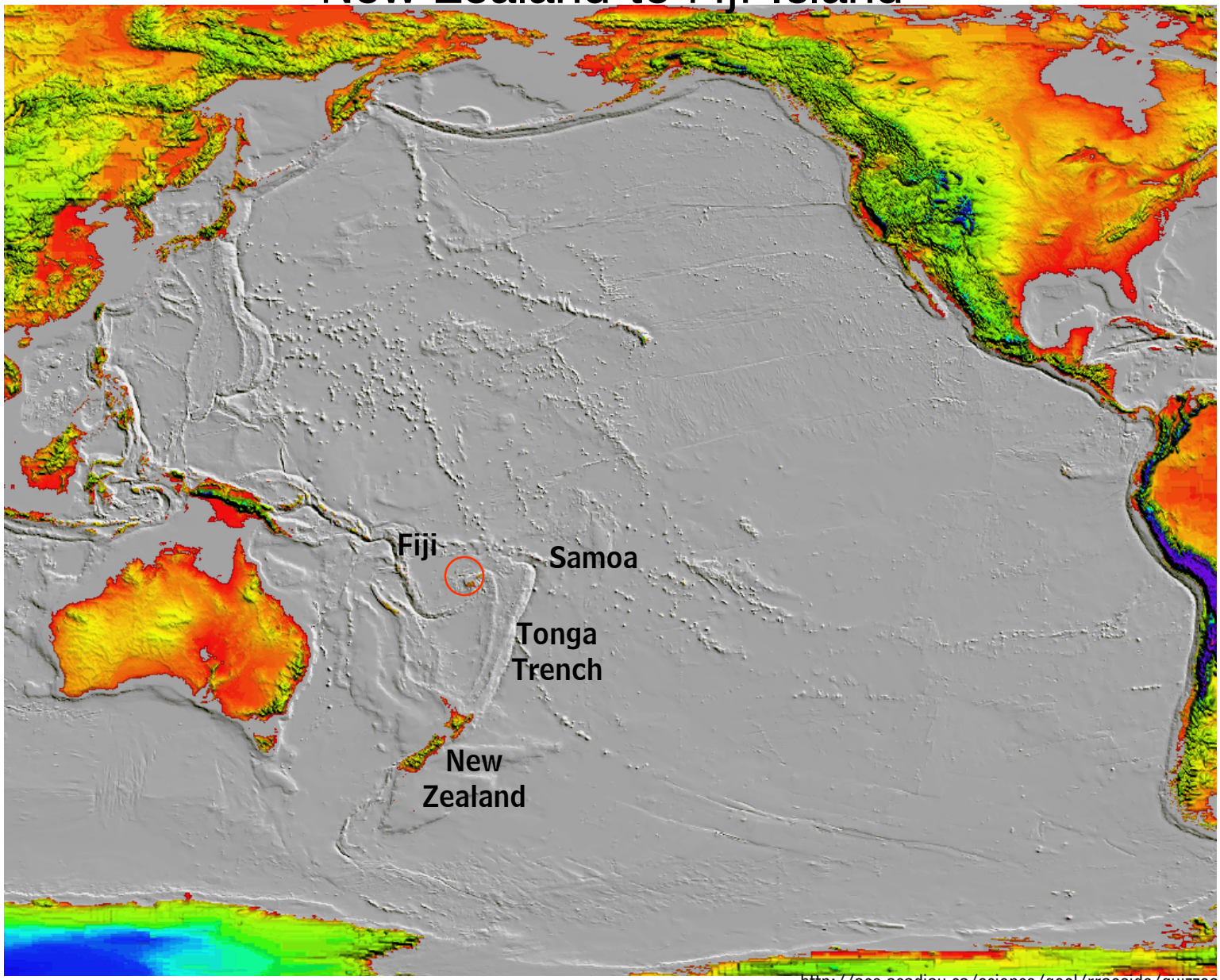
Shield Volcano



(b) Shield volcano

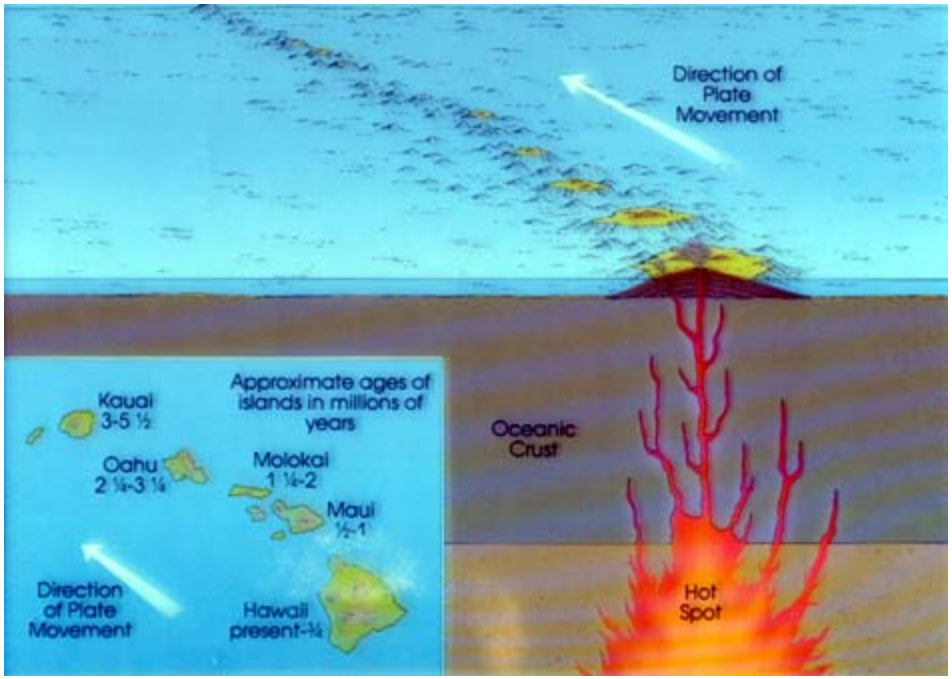
HTTP://WWW.UTEXAS.EDU/DEPTS/GRG/HUDSON/GRG301C/HUDSON_GRG_301C/SCHEDULE/3_ROCKS_EARTH_IMAGES/7_QUAKES_VOLCANISM/6.JPG

Volcanic (Island) Arc Orogeny
New Zealand to Fiji Island



http://ace.acadiau.ca/science/geol/rraeside/quizzes/worldmap3p.htm

Hawaiian Hot Spot Volcanos

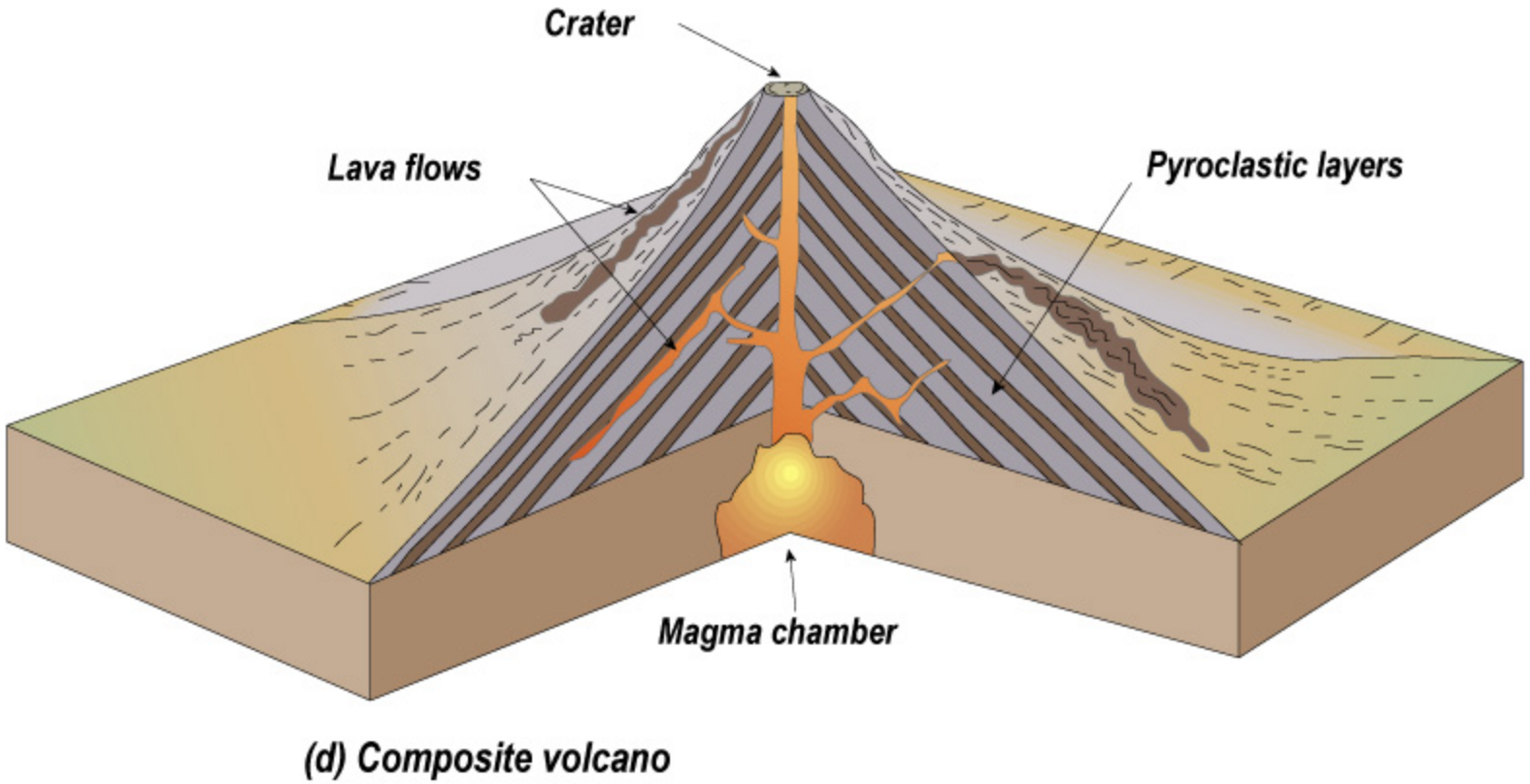


http://www.rcmurphy.net/Medina□202005/images/hawaii.jpg

http://www.travelwithachallenge.com/Images/Travel_Article_Library/Hawaii/Shield.jpg

http://www.winona.edu/geology/MRW/mrwimages/Haleakala.jpg

Composite (Strato) Volcano



http://www.utexas.edu/depts/grg/hudson/grg301c/hudson_grg_301c/schedule/3_rocks_earth_images/7_quakes_volcanism/6.jpg

Composite Volcano – Cascade Mountains – Mt. St. Helens

http://www.utexas.edu/depts/grg/hudson/grg301c/hudson_grg_301c/schedule/3_rocks_earth_images/7_quakes_volcanism/6.jpg

http://academic.emporia.edu/aberjame/tectonic/cascade/cascade.htm

Composite Volcano – Cascade Mountains – Mt. St. Helens

http://www.nides.bc.ca/Assignments/Rocks/After.htm

Composite Volcano – Cascade Mountains – Mt. St. Helens

http://academic.emporia.edu/aberjame/tectonic/cascade/cas03.jpg

Composite Volcano – Mt. Fuji

http://www.yk.rim.or.jp/~tabata/fuji/e_fuji506317.html

Composite Volcano – Mt. Augustine, Alaska

http://www.educ.uvic.ca/faculty/mroth/438/VOLCANO/august2.gif

Composite Volcano – Mt. Vesuvius

"The Eruption of Vesuvius as seen from Naples, October 1822" from V. Day & Son, *in* G. Poullet Scrope, Masson, 1864. It exemplifies a typical Plinian column with an umbrella-shaped head.

http://www.geology.sdsu.edu/how_volcanoes_work/Plinian.html

Pompeii excavated from Vesuvian eruption

http://www.nd.edu/~jmiglior/napoli/N44.jpg

Herculaneum

http://www.wbca.info/tour_bari.htm

http://upload.wikimedia.org/wikipedia/en/a/a8/Ercolano2_Copyright2003KaihsuTai.jpg

Herculaneum – casts of citizens buried in volcanic ash

http://www.utexas.edu/courses/romanciv/Romancivimages21/pompeiibody.jpg

http://www.wbca.info/images/pompeii_victim.jpg

Mt. Vesuvius from Naples

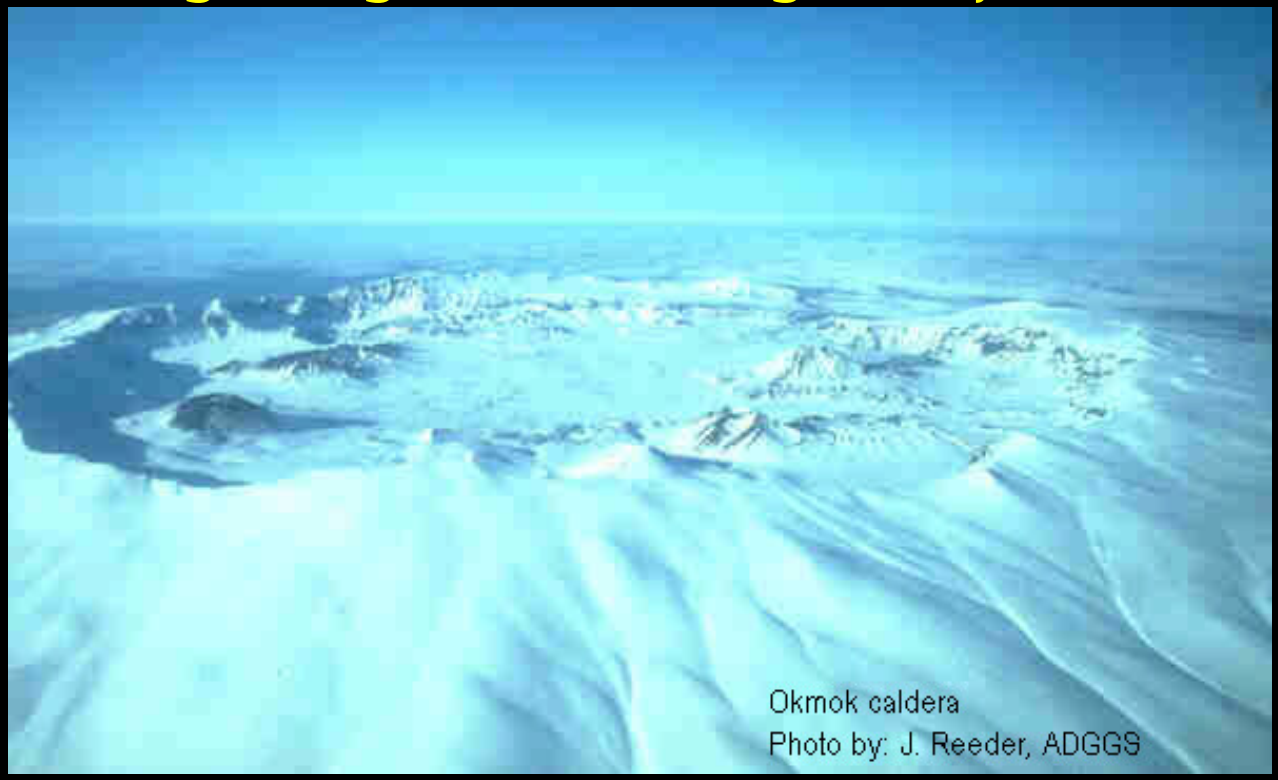
http://www.nd.edu/~jmiglior/napolipix.html

CALDERAS

Volcanoes that have blown themselves to obliteration, or have collapsed in on themselves creating a large hole in the ground, or both.

Caldera

Volcanoes that have blown themselves to obliteration, or have collapsed in on themselves creating a large hole in the ground, or both.



Okmok caldera
Photo by: J. Reeder, ADGGS

Ngorogoro Crater
East Africa

http://www.nrm.se/jourhavande_ngoro-1.gif

http://serengeti.ch/Nationalparks-Dateien/Ngorongoro.jpg

Ngorogoro Crater
East Africa

http://serengeti.ch/Nationalparks-Dateien/Ngorongoro.jpg

Crater Lake Oregon

HTTP://WWW.OLYMPIC.CTC.EDU/CLASS/SMACIAS/CRATER_LAKE_AERIAL.GIF

Valles Caldera, New Mexico

HTTP://WWW.LPI.USRA.EDU/SCIENCE/TREIMAN/GREATDESERT/WORKSHOP/VALLESGEOL2/VAL

Santorini Caldera, Mediterranean Sea

http://astro.temple.edu/~andy/Contents/Courses/photo_images/santorini.jpeg

The Minoan Civilization and the Myth of Atlantis

The Greek philosopher Plato (427-347 BC) describes in his dialogs *Critias* and *Timaeus* the disappearance of ***Atlantis***, a circular island populated by talented people of high culture and wealth. the ring-shaped group of islands known as Santorini includes **Thera** (the largest), **Therasia** (little Thera), **Aspronisi**, and the central **Kameni Islands**.

http://www.geology.sdsu.edu/how_volcanoes_work/santorini.html

Santorini, the Lost City of Atlantis, and the Minoans

Thera have revealed Bronze Age ruins of a particularly large and vibrant city, with well-preserved frescos and paintings, together with numerous artifacts. The artifacts indicate that the island of Thera was colonized by the Minoans, a Bronze Age civilization named after the legendary King Minos of Crete. Thera appears to have had a thriving Minoan economy provided by intensive trade throughout the eastern Mediterranean. Today, the remains of this flourishing community lie buried under a thick blanket of pumice generated by a massive Late Bronze Age eruption. The exact date of the eruption remains somewhat controversial, although most radiometric studies show that it falls between 1615-1645 BC, consistent with a pronounced acid-ice layer from the Greenland cores, dated at 1636 BC.

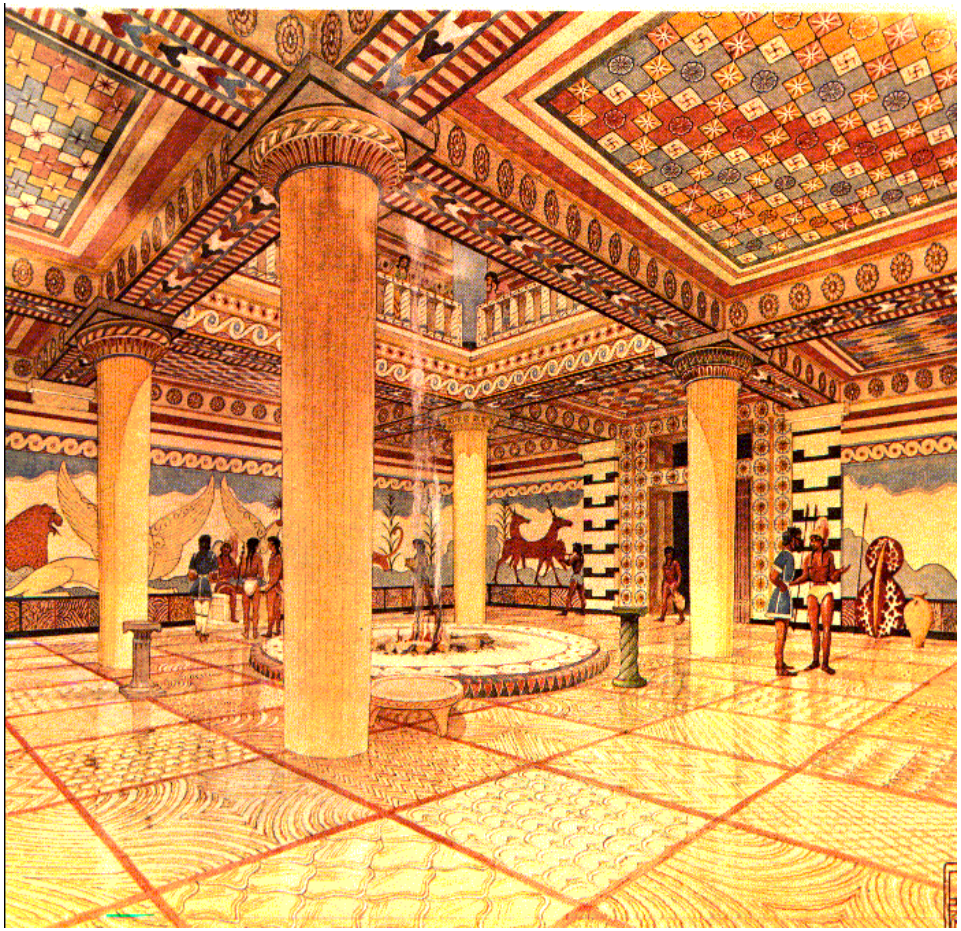
Santorini Island Group *-- The large, ring-shaped island of Thera encloses most of the caldera, with the smaller island, Therasia, in the foreground. The town of Fira, and adjacent villages, appears as a small white layer on the central rim of the caldera. The darker young volcanic islands of Palea and Nea Kameni in the center of the caldera.* *Coutesy of Birke Schreiber (copyright: Hankensbuettel, Germany - www.kalliste.de).*

Santorini Caldera

http://oncampus.richmond.edu/academics/classics/photos/santorini.html

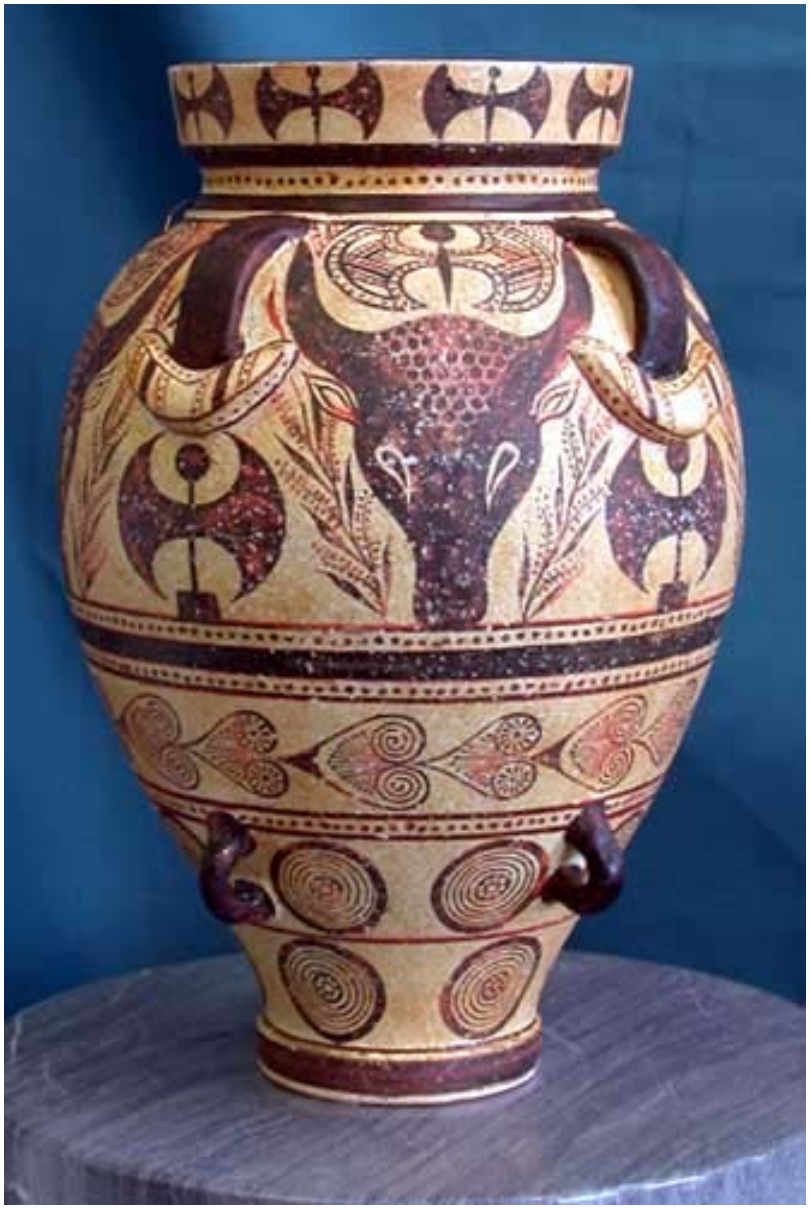
Santorini, the Lost City of Atlantis, and the Minoans

http://www.magicaljourneys.com/Santorini/santorini_history.jpg



http://www.worldses.org/conferences/2004/crete/location_files/minoan.gif

Santorini, the Lost City of Atlantis, and the Minoans



http://www.prometheus-imports.com/worship-vase-minoan-l.jpg

http://www.utexas.edu/courses/gciv/images/Minoan_girl_profile.jpg

Santorini, the Lost City of Atlantis, and the Minoans

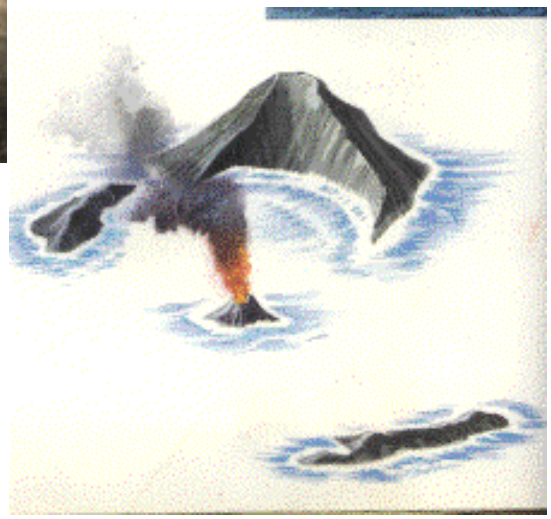
http://www.utexas.edu/courses/gciv/Lecture_02.html

More images http://www.utexas.edu/courses/gciv/Lecture_02.html

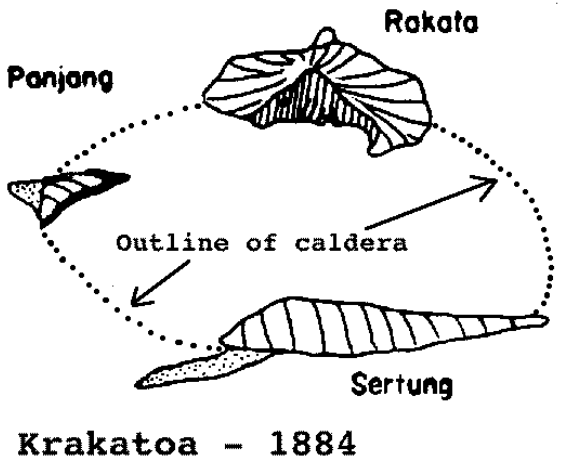
Krakatoa caldera – Sunda Straight, Indonesia

http://fonds-ancien.ensmp.fr/Ouvrages_rem/Images/krakatoa.jpg

http://www.enc.org/Classroom_Calendar/CC_Images/Unit_Images/Krakatoa_Anak.jpg



http://www.drgeorgepc.com/tsu1883KrakatoaAfter.gif



http://www.geol.binghamton.edu/faculty/naslund/Krak84.GIF

Krakatoa caldera – Sunda Straight, Indonesia

Krakatoa (also spelled Krakatau), a volcano located in the Sunda Strait in what is now the nation of Indonesia, blew up on August 27, 1883. Other volcanoes have been larger, have emitted more ash and material into the air, and have resulted in more death and destruction, but the eruption of Krakatoa was the first event recorded globally by scientists and newspapers.

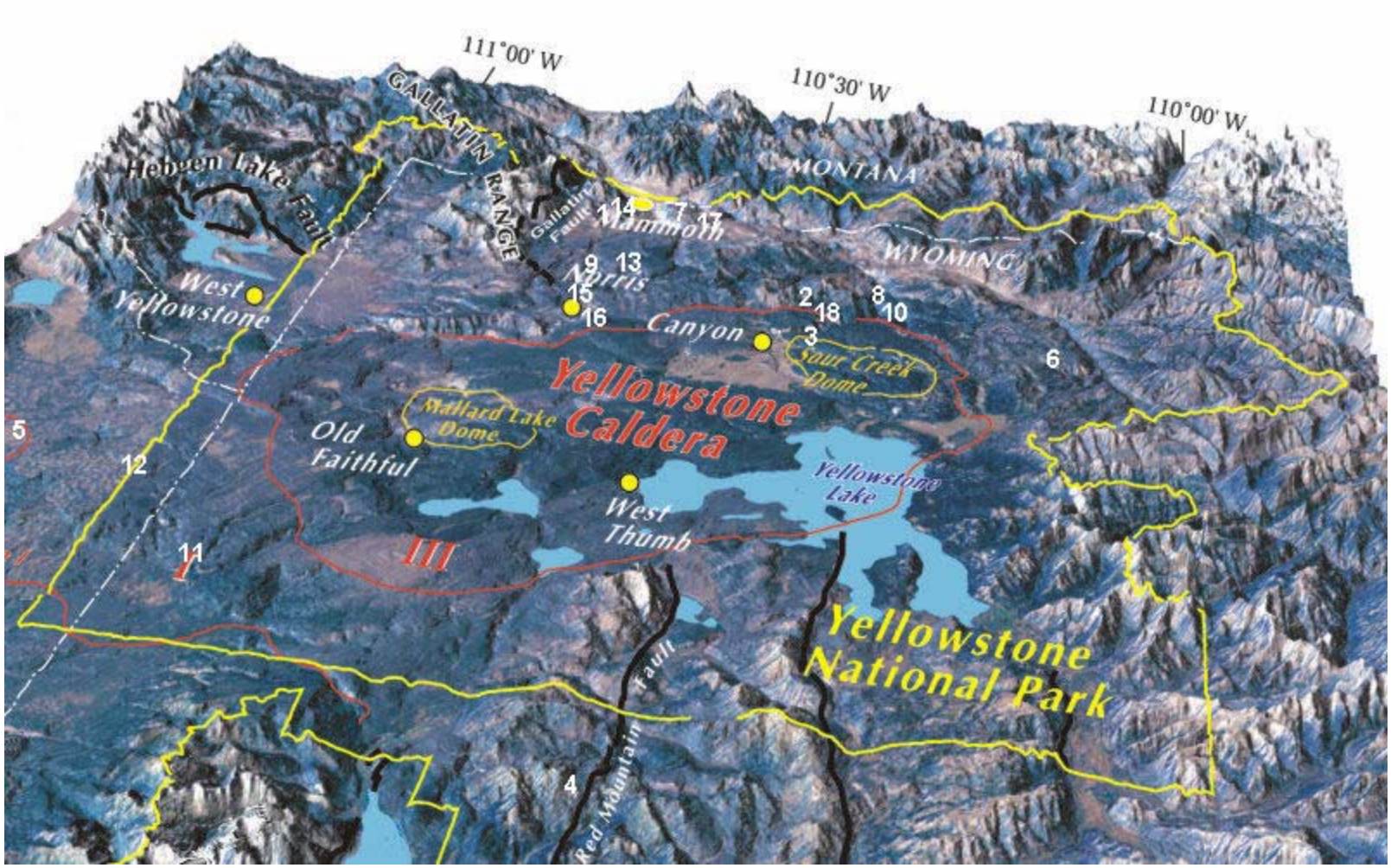
The surface pressure waves from the eruption of Krakatoa registered a distinctive 2-hour pattern--like an earthquake in the air, according to Winchester. The volcano sent out this inaudible shock wave that traveled at approximately 700 miles (1,126 km) per hour. And the wave moved around the Earth seven times! The eruption also produced an audible sound wave heard nearly 3,000 miles (4,828 km) away, the equivalent of hearing an explosion in New York City that happened in San Francisco.

Tsunamis, colder temperatures, and brilliant sunsets resulted from the Krakatoa eruption and also spread across the globe. The sea waves did not travel around the globe, but were recorded as far away as the south coast of France, 10,000 nautical miles (18,520 km) from the volcano. The sea waves traveled as fast as 400 miles (644 km) per hour and moved south and west of the volcano because of the reefs, sandbanks, and other impediments to the east.

The effect of the eruption on temperature was not studied until 1913, 30 years after the eruption. It showed that there was a 1 degree Fahrenheit drop in temperature, consistent with what is known about the effect of other volcanic eruptions. Today, we can find evidence of the eruption in layers of volcanic ash deposited in ice cores and frost rings in trees that have suffered through a cold winter.

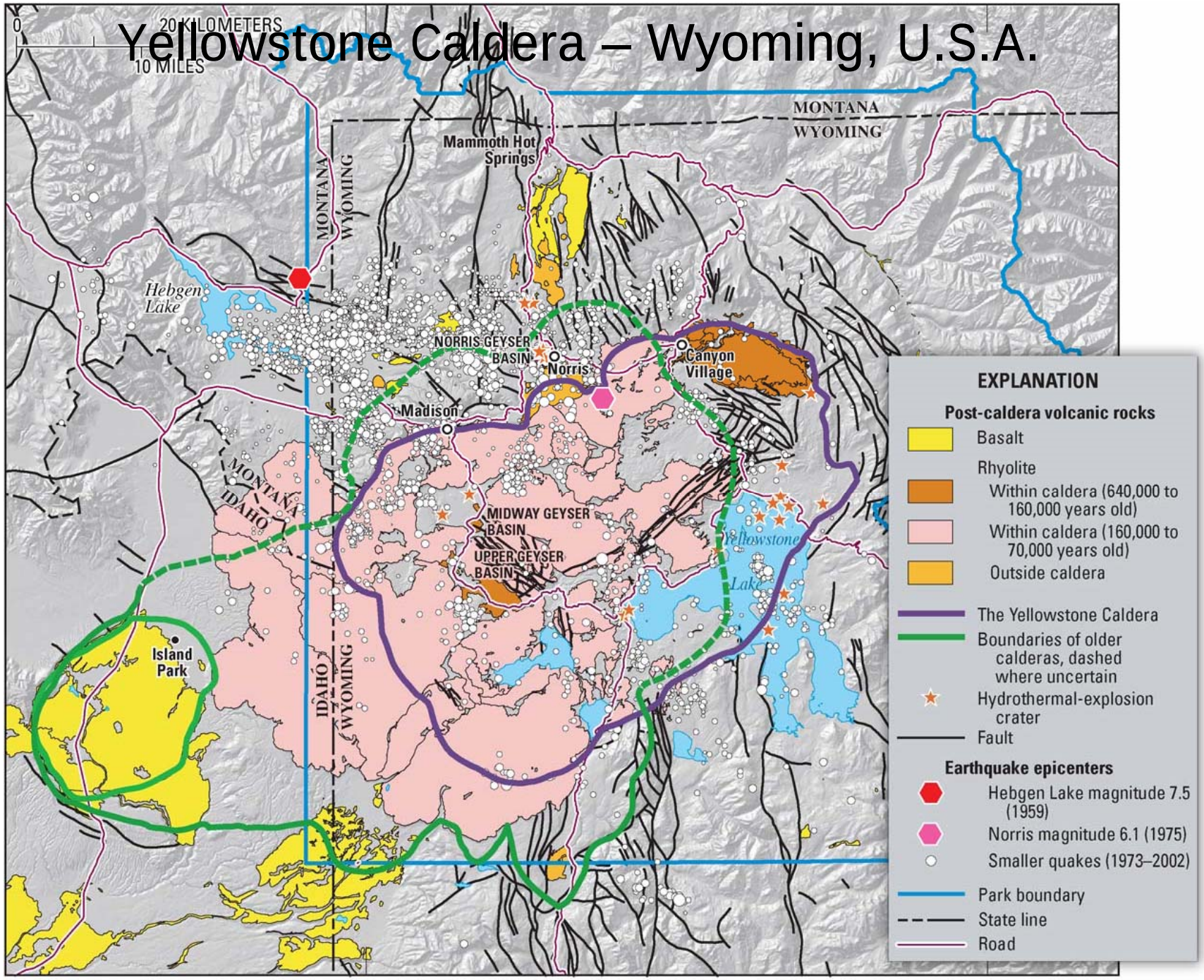
http://www.enc.org/features/calendar/unit/0,1819,225,00.shtm

Yellowstone Caldera – Wyoming, U.S.A.



http://volcanoes.usgs.gov/yvo/images/2000-rbs-1.4ytspaceviewzoom_large2a.jpg

Yellowstone Caldera – Wyoming, U.S.A.



http://pubs.usgs.gov/fs/2005/3024/

Yellowstone Caldera – Wyoming, U.S.A.

http://www-user.tu-chemnitz.de/~strk/Pictures/road_trip/Yellowstone_Mud_Volcano_Mammoth/yellowstone_mud.html