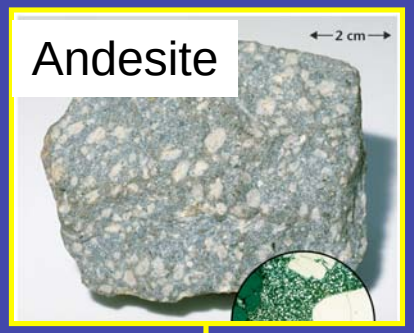




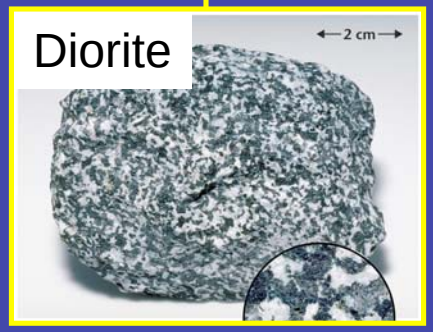




Extrusive: erupted at Earth's surface
Generally relatively fine-grained

Intrusive: never erupted
Generally relatively coarse-grained





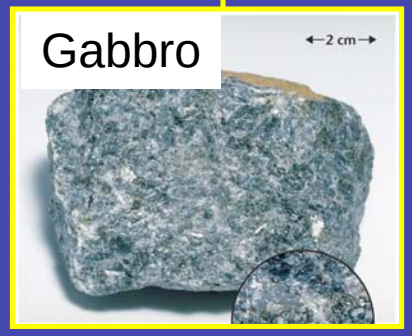




Table 4.1 Magmas have different compositions, which cause their properties to vary

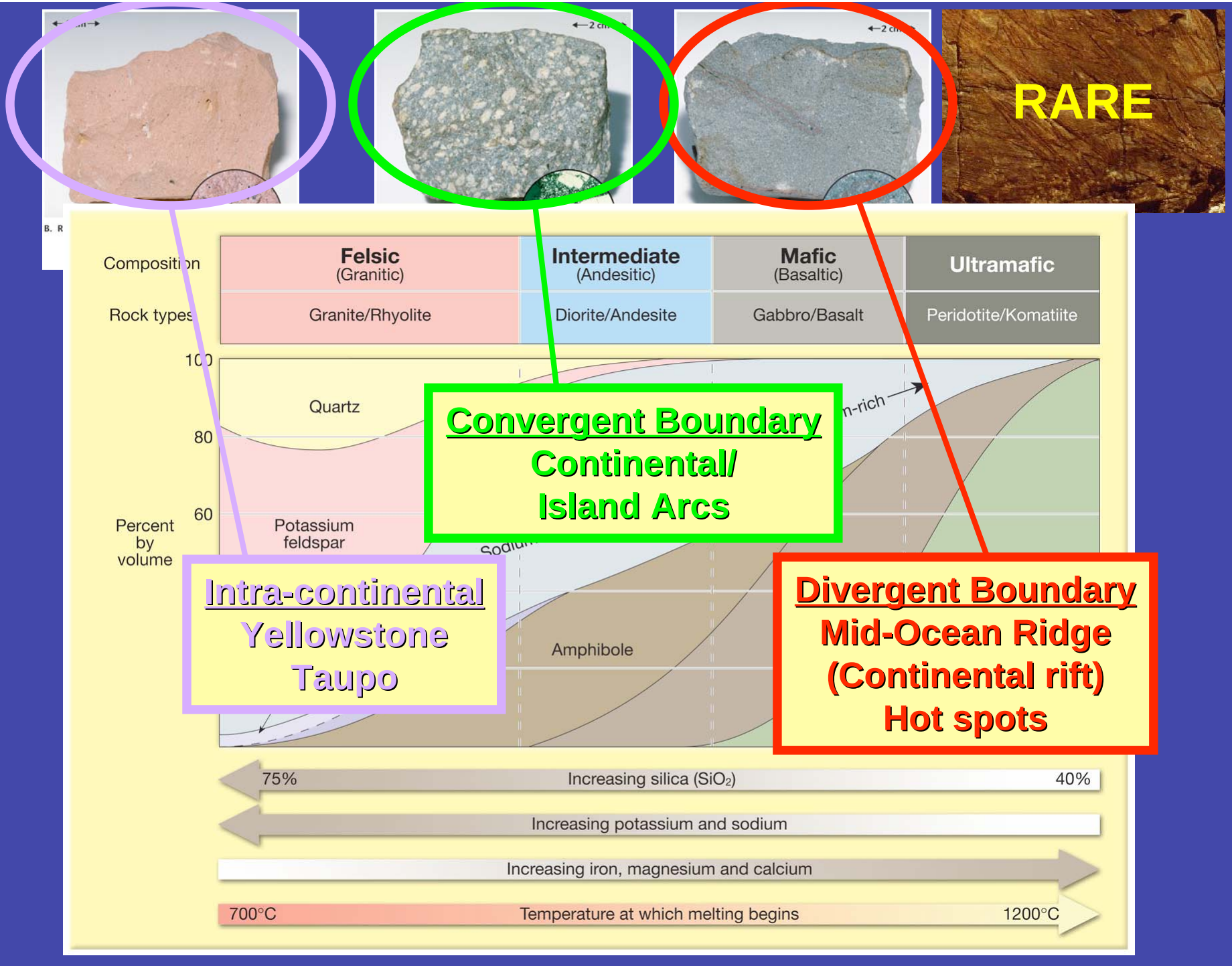
Composition	Silica Content	Viscosity	Gas Content	Tendency to Form Pyroclastics	Volcanic Landform
Mafic (Basaltic) magma	Least (~50%)	Least	Least (1–2%)	Least	Shield Volcanoes Basalt Plateaus Cinder Cones
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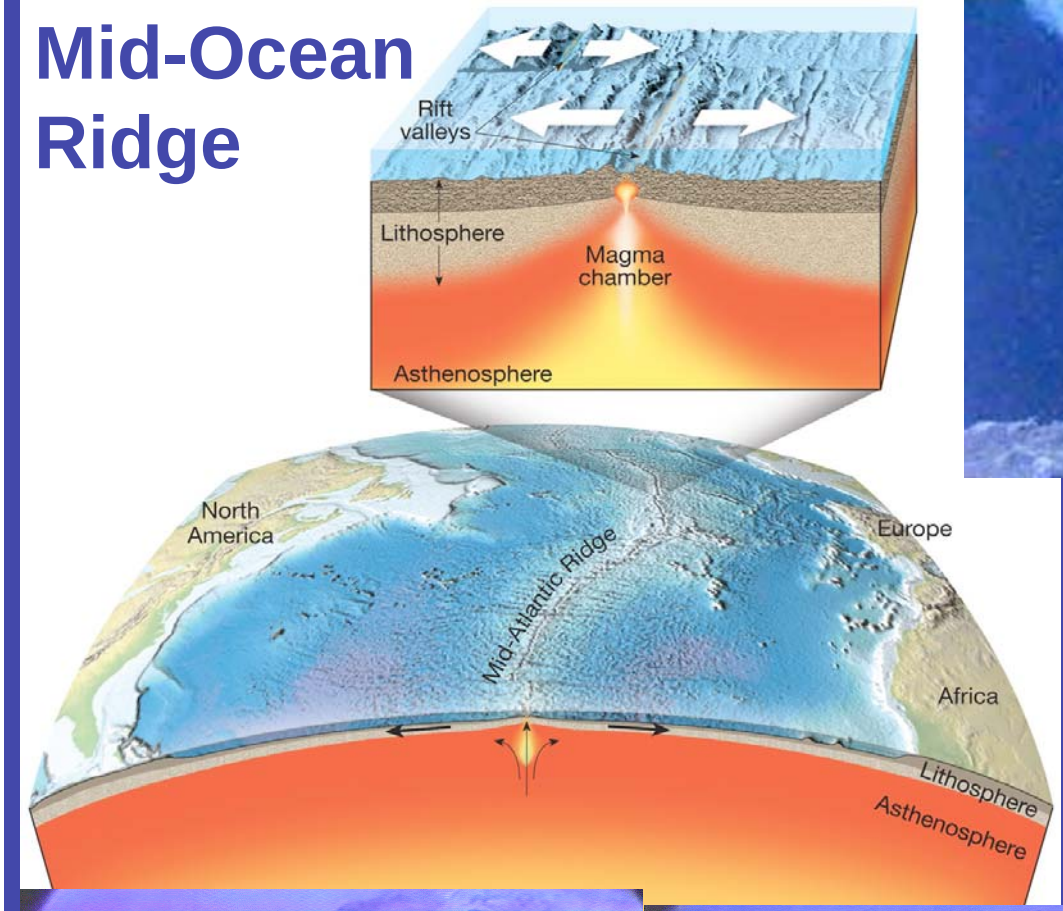




Where would you expect to find each of these?


RARE
Composition
Felsic
(Granitic)
Intermediate
(Andesitic)
Mafic
(Basaltic)
Ultramafic
Rock types
Granite/Rhyolite
Diorite/Andesite
Gabbro/Basalt
Peridotite/Komatiite
100
80
60
Percent by volume
Quartz
Potassium feldspar
Amphibole
n-rich
Convergent Boundary
Continental/
Island Arcs
Intra-continental
Yellowstone
Taupo
Divergent Boundary
Mid-Ocean Ridge
(Continental rift)
Hot spots
75%
Increasing silica (SiO2)
40%
Increasing potassium and sodium
Increasing iron, magnesium and calcium
700°C
Temperature at which melting begins
1200°C

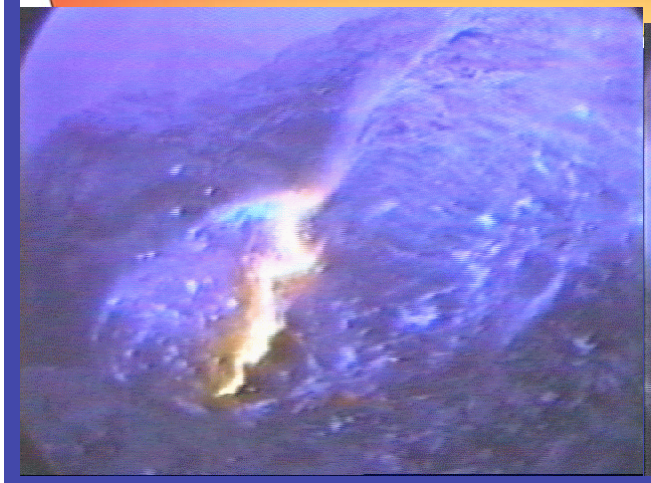
Mid-Ocean Ridge



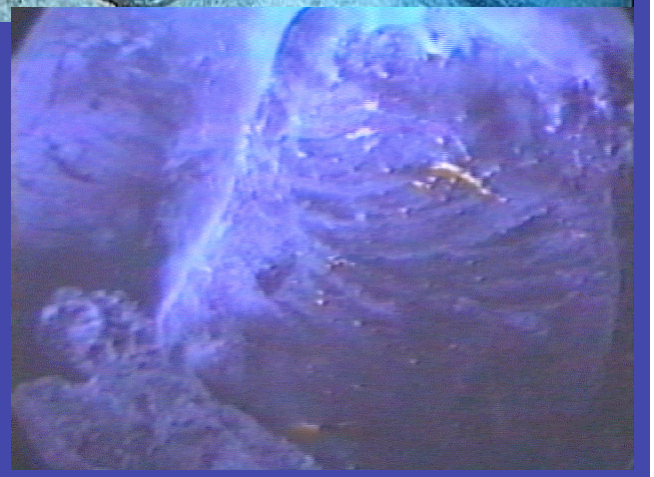


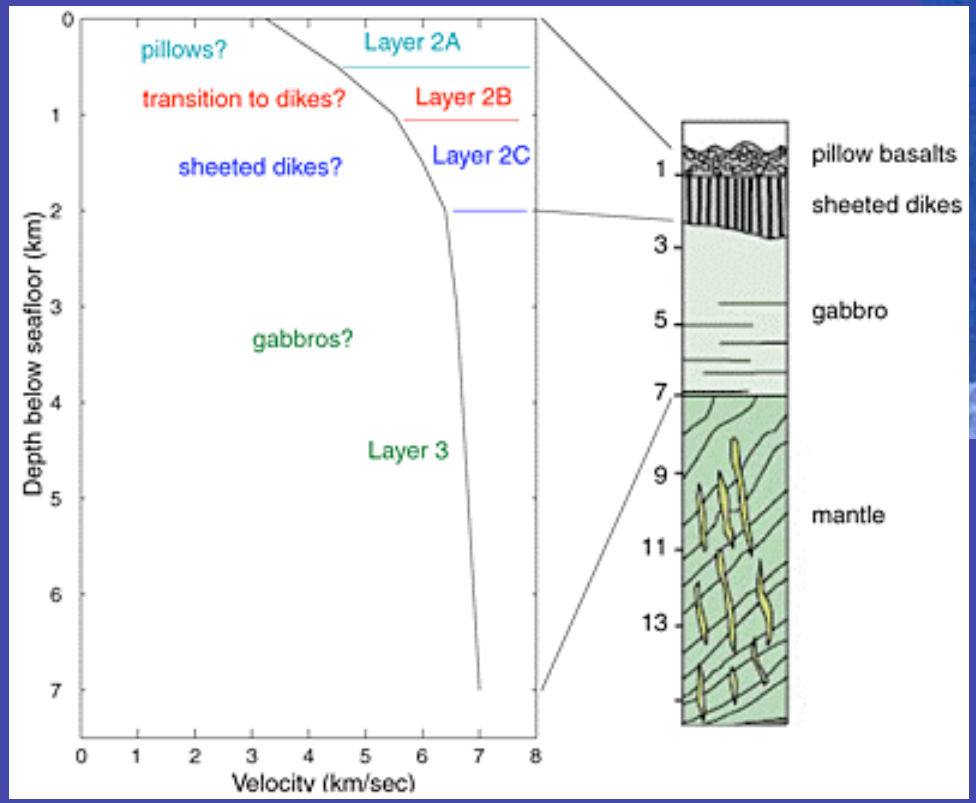


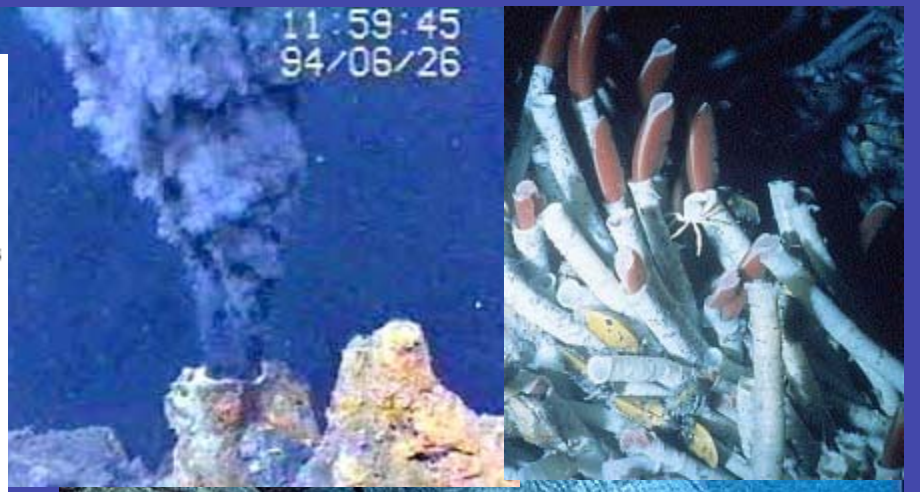




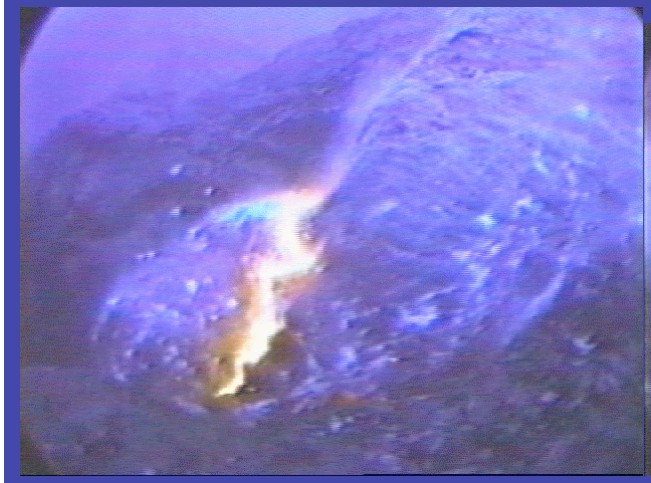


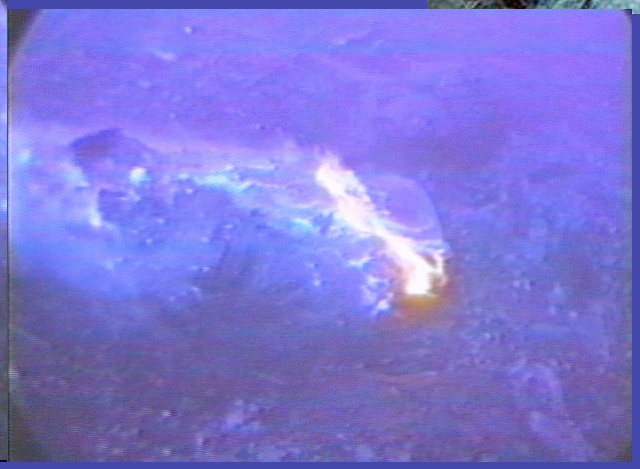


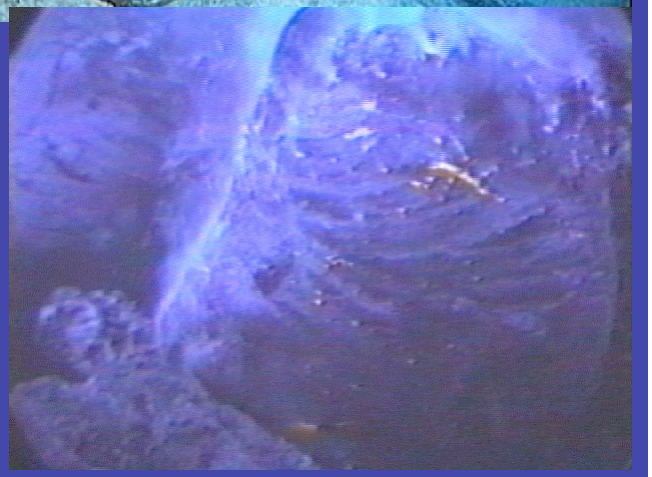

pillows?
Layer 2A
transition to dikes?
Layer 2B
Layer 2C
sheeted dikes?
gabbros?
Layer 3
Depth below seafloor (km)
Velocity (km/sec)
pillow basalts
sheeted dikes
gabbro
mantle


11:59:45
94/06/26

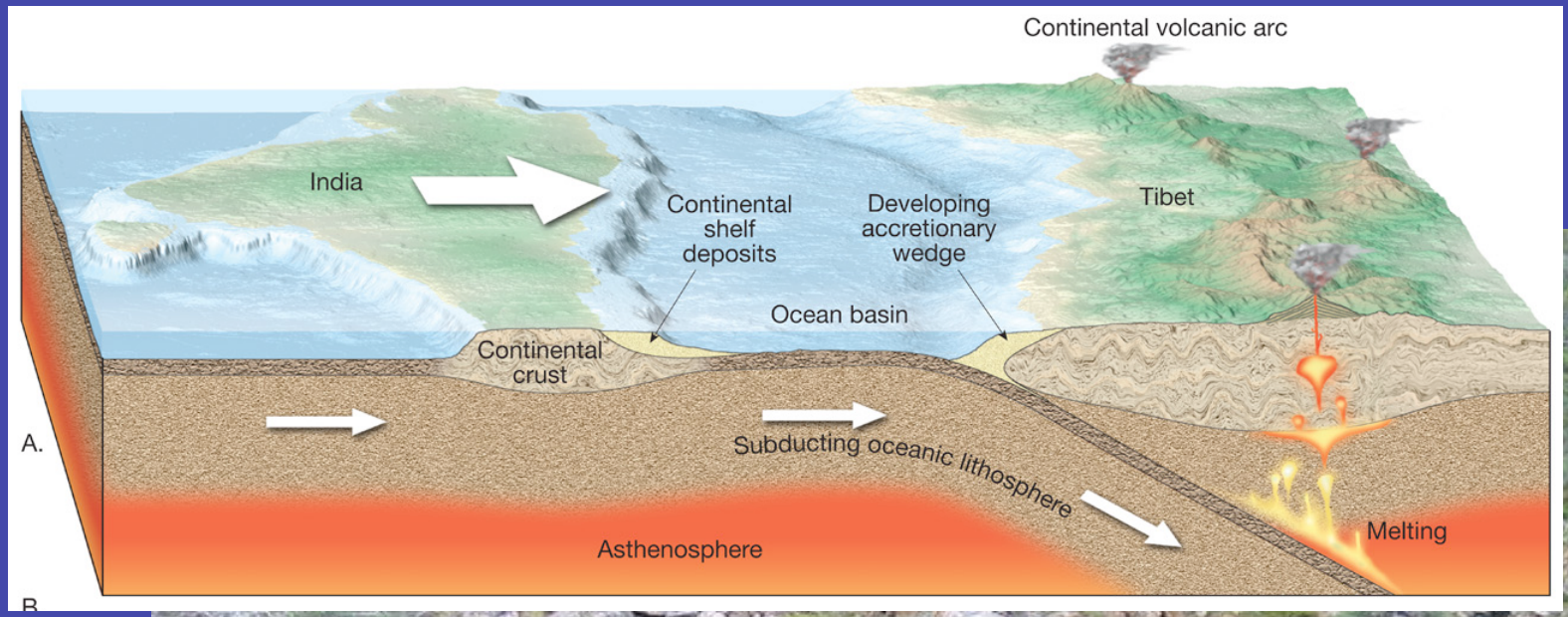












Ophiolite complex – oceanic crust on land

Table 4.1 Magmas have different compositions, which cause their properties to vary

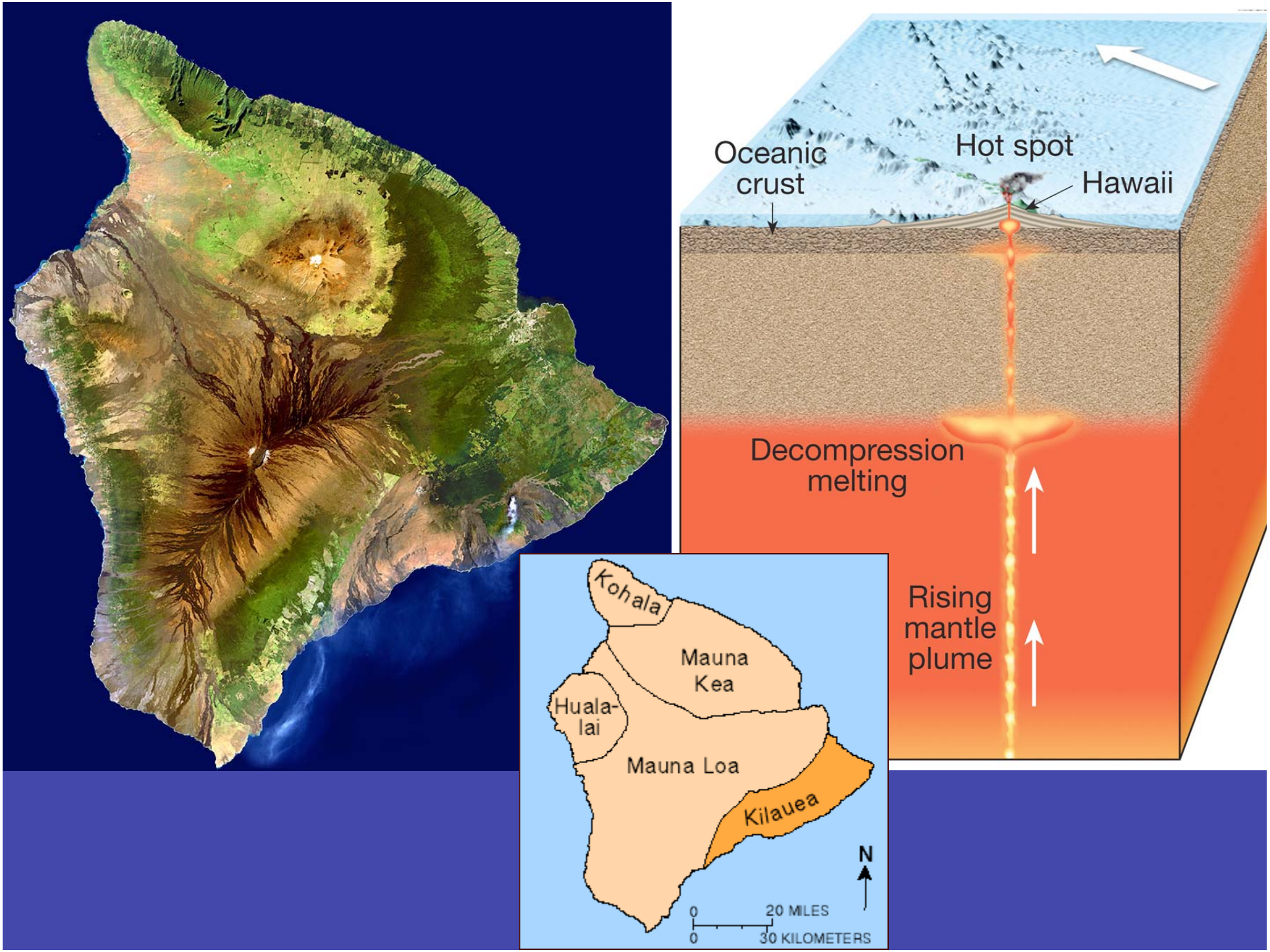
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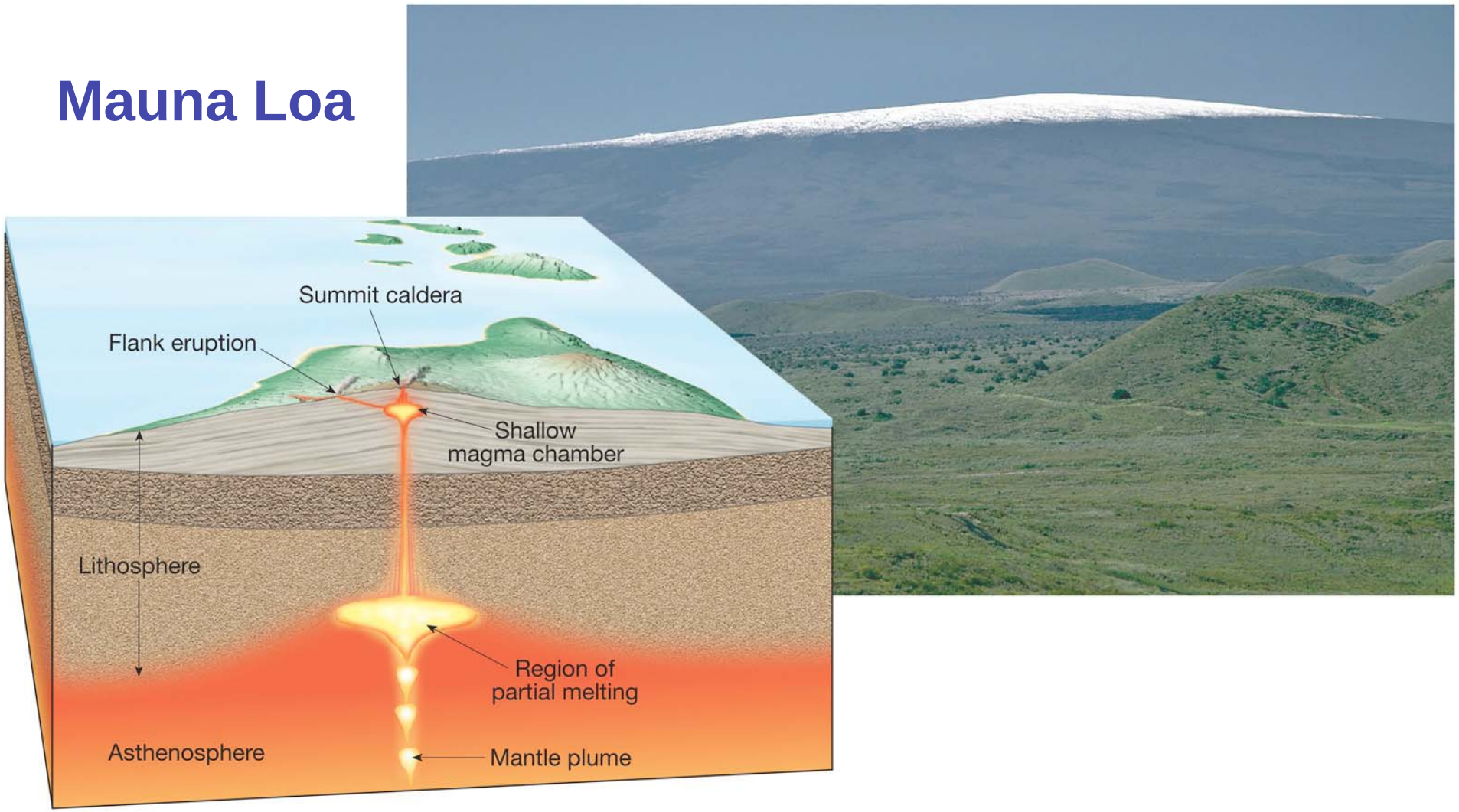




Oceanic hot spots

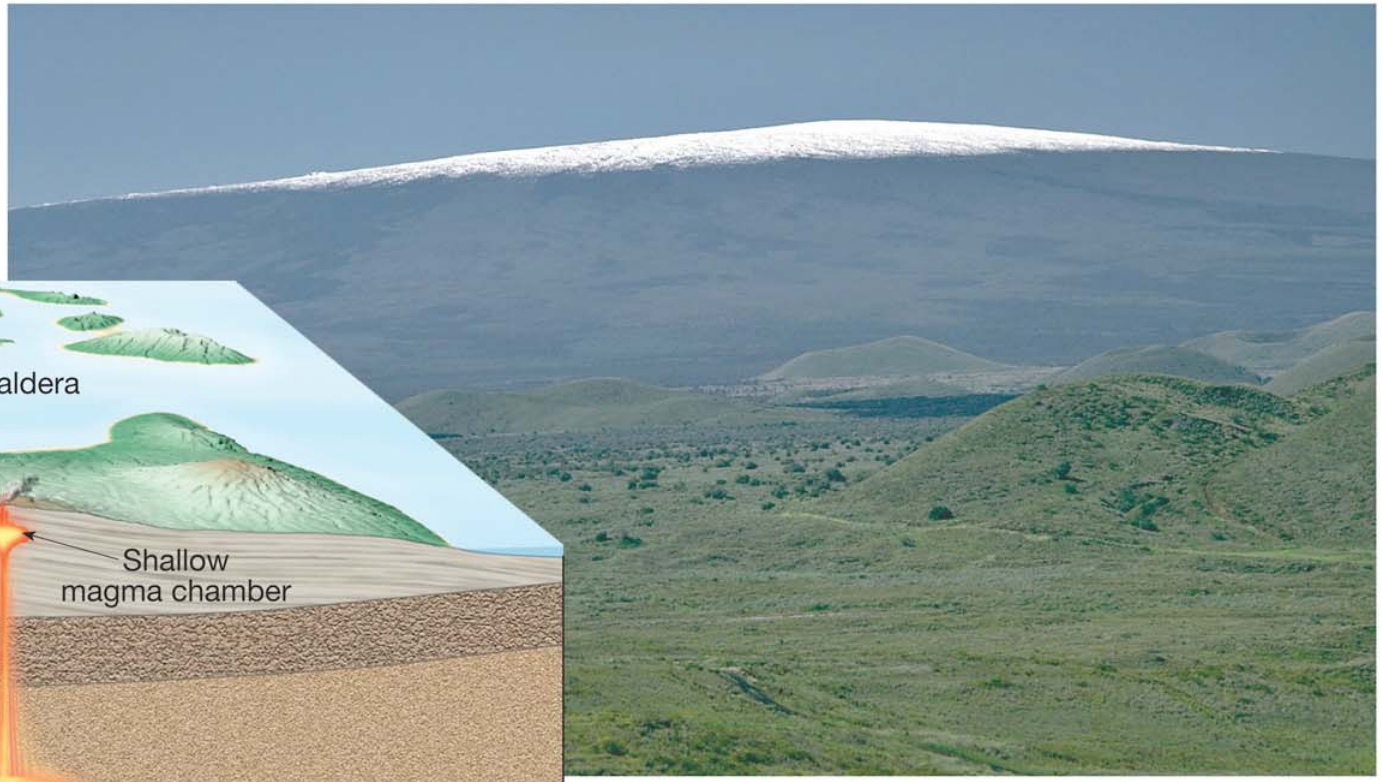

Oceanic crust
Hot spot
Hawaii
Decompression melting
Rising mantle plume
Kohala
Mauna Kea
Hualalai
Mauna Loa
Kilauea
N
0 20 MILES
0 30 KILOMETERS

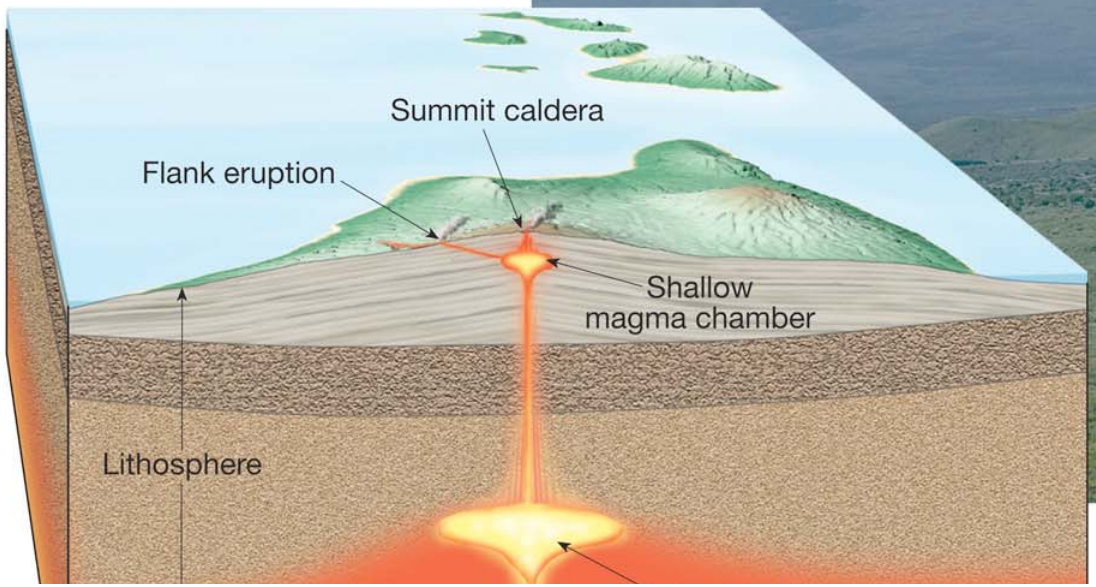
Mauna Loa

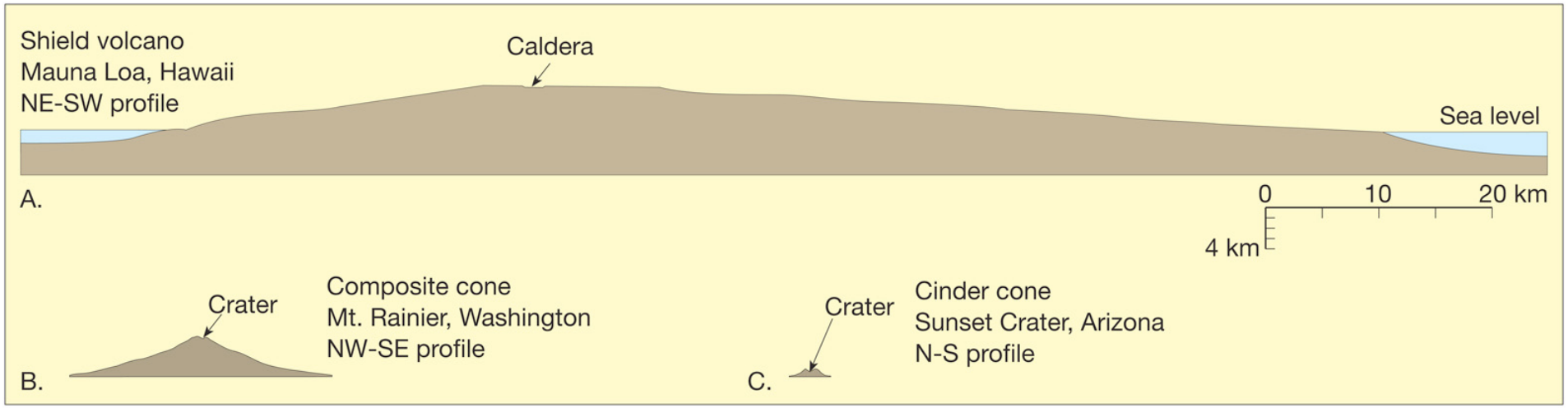


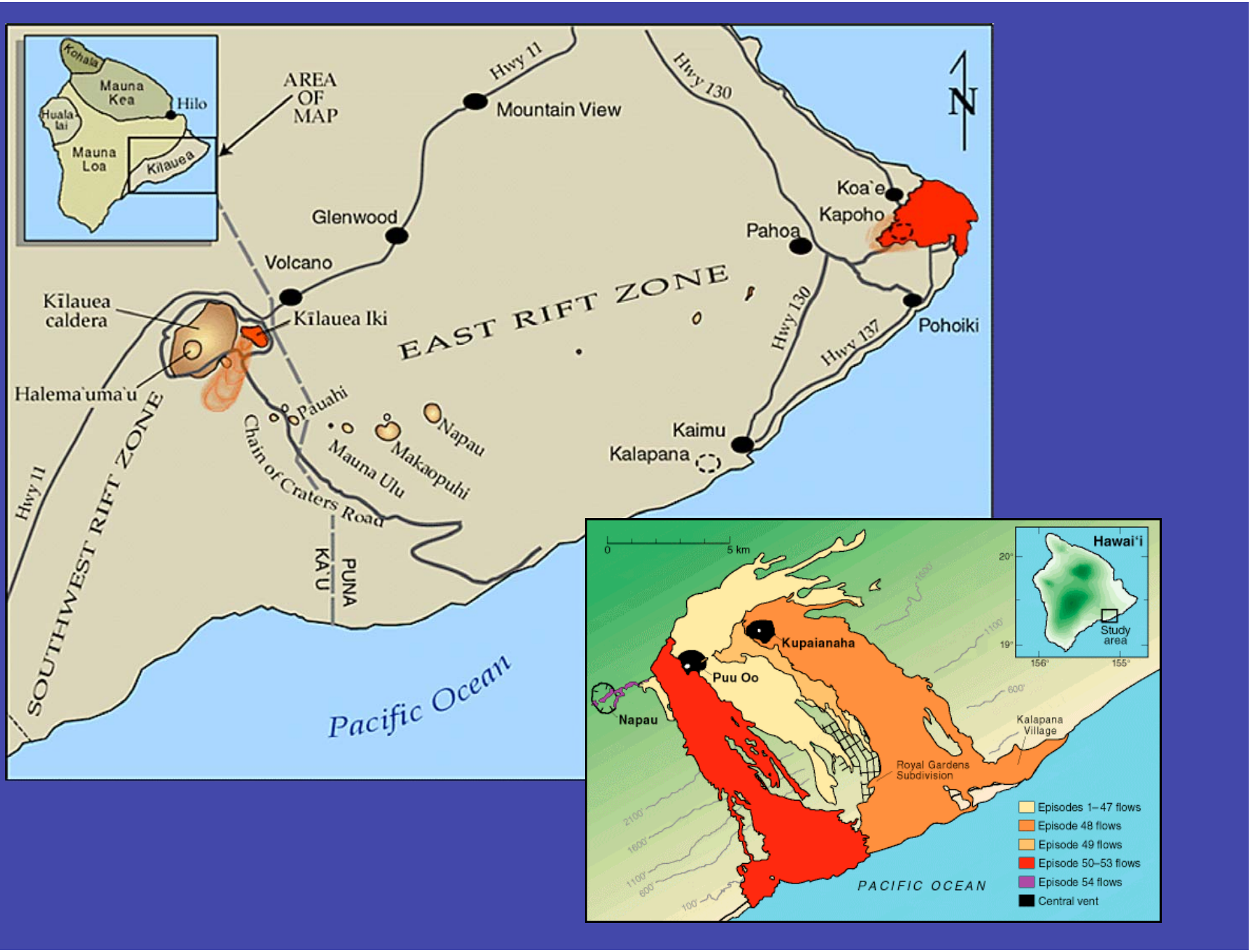
Why is this called a shield volcano?

Mauna Loa




Summit caldera
Flank eruption
Shallow
magma chamber
Lithosphere


Shield volcano
Mauna Loa, Hawaii
NE-SW profile
Caldera
Sea level
A.
0
10
20 km
4 km
Crater
Composite cone
Mt. Rainier, Washington
NW-SE profile
B.
Crater
Cinder cone
Sunset Crater, Arizona
N-S profile
C.


Kohala
Mauna Kea
Hilo
Hualalai
Mauna Loa
Kilauea
AREA OF MAP
Hwy 11
Mountain View
Hwy 130
N
Koa`e
Kapoho
Glenwood
Pahoa
Volcano
EAST RIFT ZONE
Kīlauea caldera
Kīlauea Iki
Hwy 130
Hwy 137
Pohoiki
Halema`uma`u
Pauahi
Napau
Makaopuhi
Mauna Ulu
Chain of Craters Road
Kaimu
Kalapana
Hwy 11
SOUTHWEST RIFT ZONE
KA`U
PUNA
Pacific Ocean
0
5 km
Hawai`i
Study area
Kupaianaha
Puu Oo
Napau
Kalapana Village
Royal Gardens Subdivision
PACIFIC OCEAN
Episodes 1–47 flows
Episode 48 flows
Episode 49 flows
Episode 50–53 flows
Episode 54 flows
Central vent


Pahoehoe

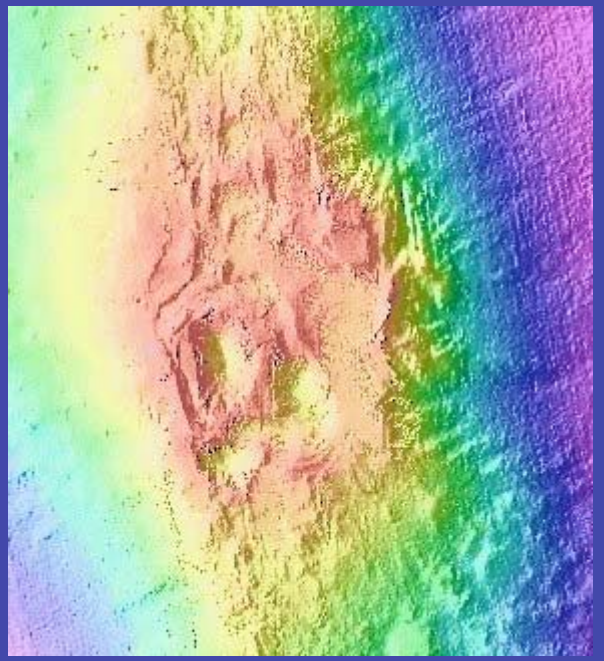

2 cm

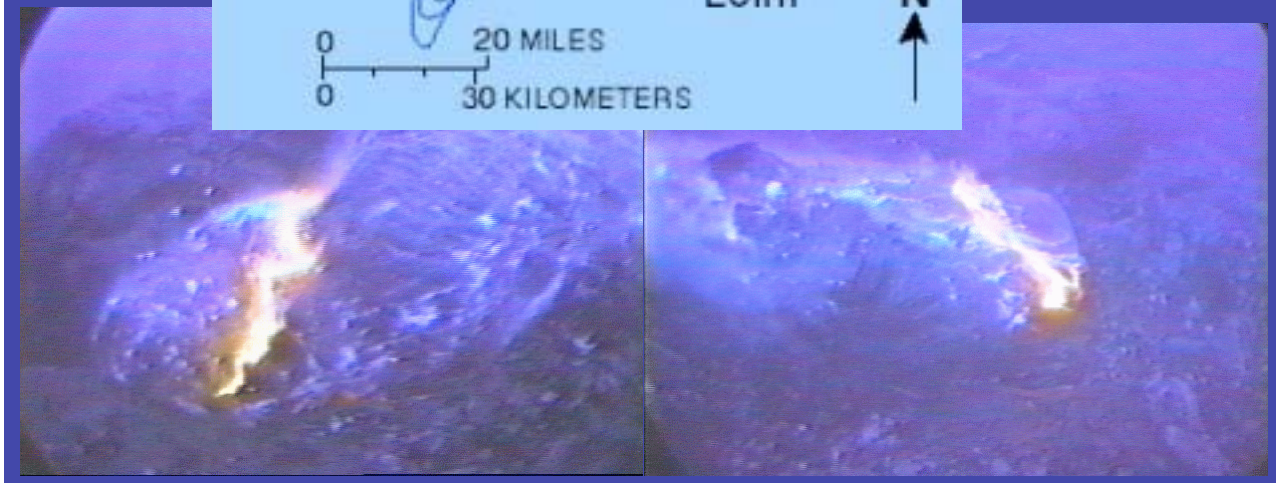


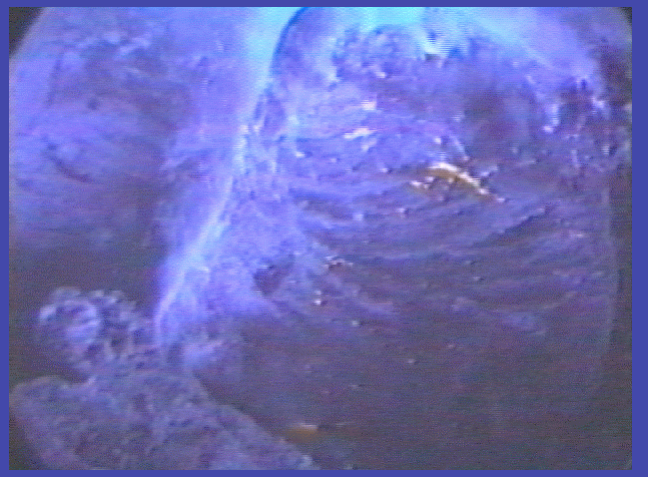

Aa

Loihi Seamount











Locations of world's volcanoes

Most are related to what kind of boundary?

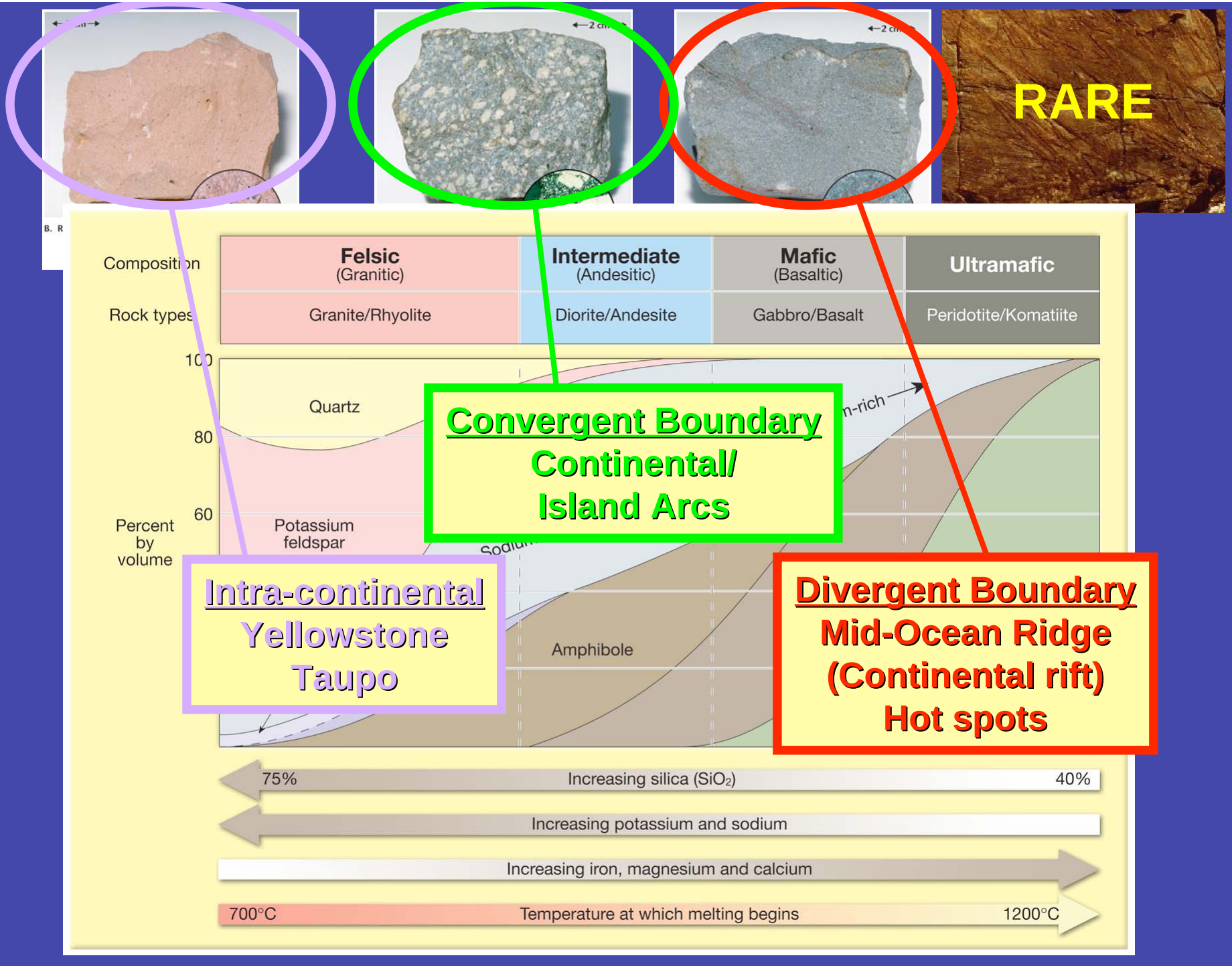

RARE
Composition
Felsic
(Granitic)
Intermediate
(Andesitic)
Mafic
(Basaltic)
Ultramafic
Rock types
Granite/Rhyolite
Diorite/Andesite
Gabbro/Basalt
Peridotite/Komatiite
100
80
60
Percent by volume
Quartz
Potassium feldspar
Amphibole
n-rich
Convergent Boundary
Continental/
Island Arcs
Intra-continental
Yellowstone
Taupo
Divergent Boundary
Mid-Ocean Ridge
(Continental rift)
Hot spots
75%
Increasing silica (SiO2)
40%
Increasing potassium and sodium
Increasing iron, magnesium and calcium
700°C
Temperature at which melting begins
1200°C

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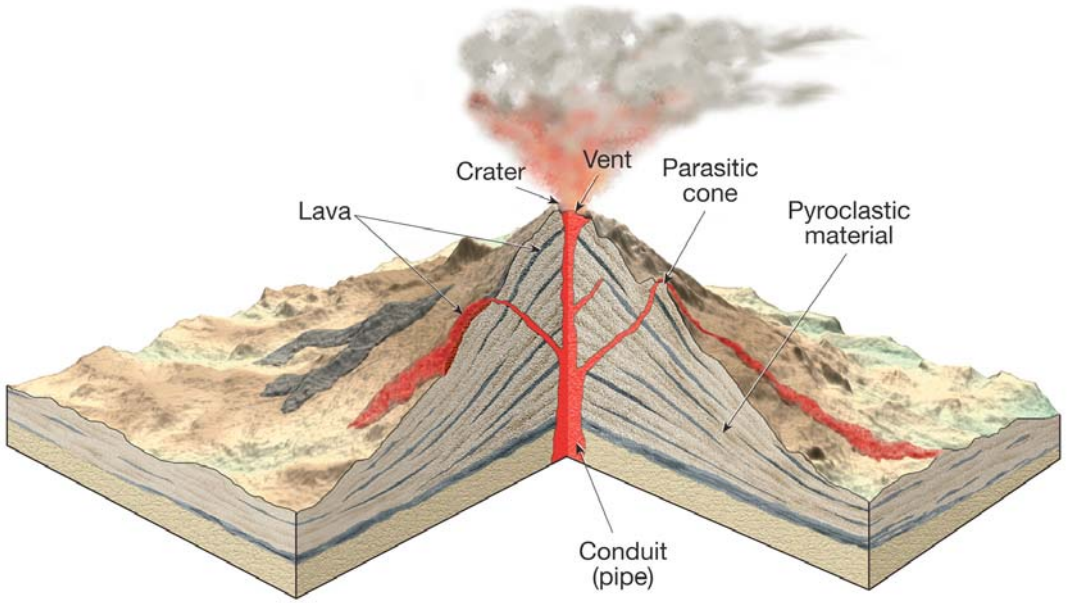


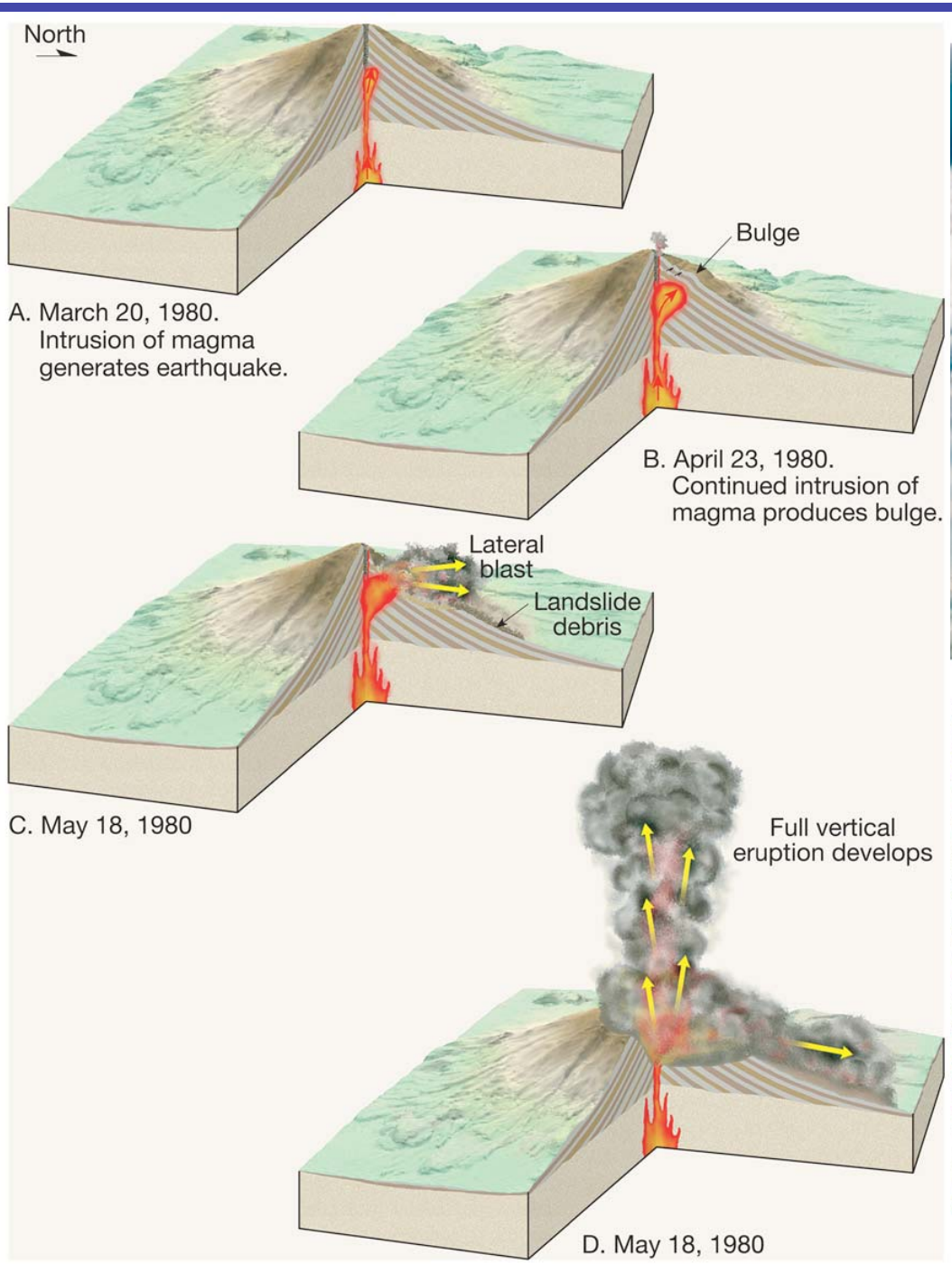




Convergent boundaries

Composite cones
Cinder cones




North
A. March 20, 1980.
Intrusion of magma
generates earthquake.
Bulge
B. April 23, 1980.
Continued intrusion of
magma produces bulge.
Lateral
blast
Landslide
debris
C. May 18, 1980
Full vertical
eruption develops
D. May 18, 1980







Before…



After…









Mudflows



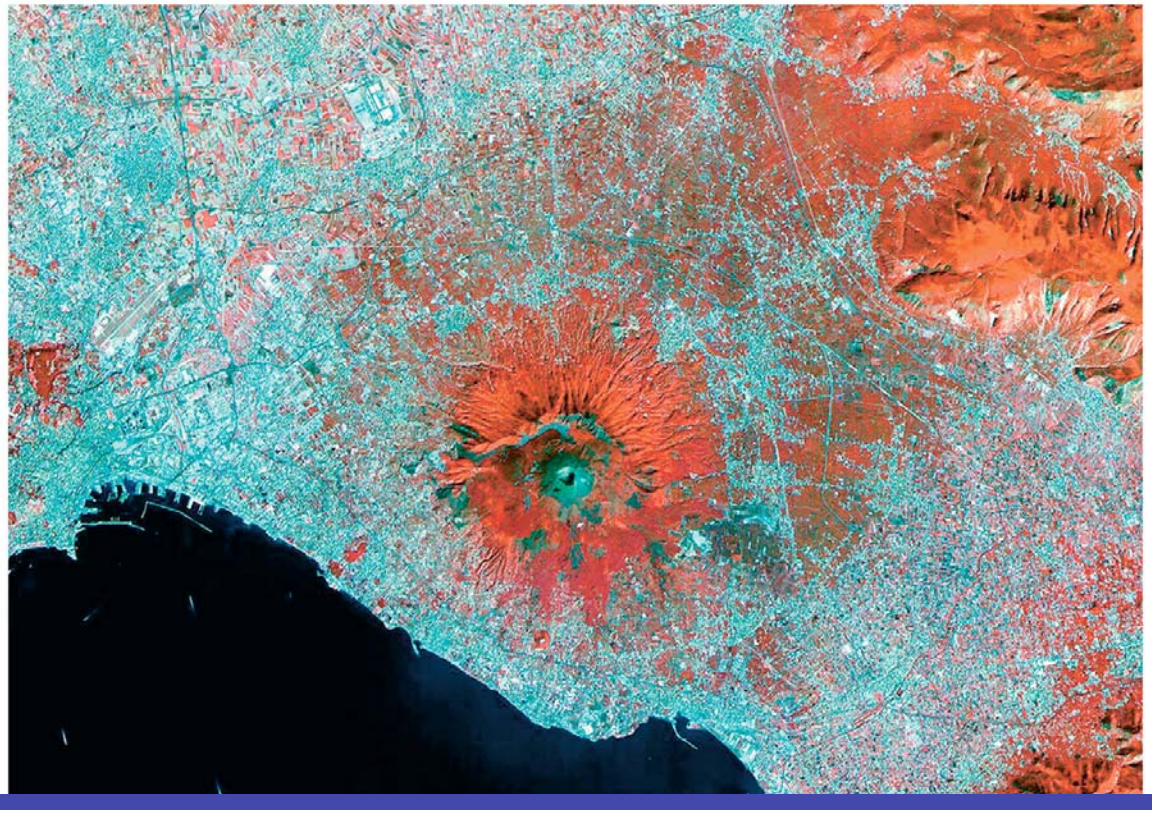
Mt. Mayon, Philippines, 1984



Pyroclastic Flows







Volcanic hazards from stratovolcanoes (convergent boundaries)

1) **Mudflows**

2) **Pyroclastic flows**

Volcanic explosivity index (VEI)

VEI	Classification	Description	Plume	Ejecta volume	Frequency	Example	Occurrences
0	Hawaiian	Non-explosive	< 100 m	> 1000 m^3	Daily	Mauna Loa	--
1	Hawaiian/ Strombolian	Gentle	100-1000 m	>10,000 m^3	Daily	Kilauea	--
2	Strombolian/ Vulcanian	Explosive	1-5 km	>1,000,000 m^3	Weekly	Mt. Hood	3,477
3	Vulcanian/ Pelean	Severe	3-15 km	>10,000,000 m^3	Yearly	Mt. Vesuvius	868
5	Plinian	Paroxysmal	>25 km	>1 km^3	≥ 50 yrs	St. Helens	84
6	Plinian/ Ultra-Plinian	Colossal	>25 km	>10 km^3	≥ 100 yrs	Mt. Pinatubo	39
7	Plinian/ Ultra-Plinian	Super-colossal	>25 km	>100 km^3	≥ 1000 yrs	Santorini	4
8	Ultra-Plinian	Mega-colossal	>25 km	>1000 km^3	≥ 10,000 yrs	Yellowstone	--

Paroxysm: a spasm or fit; a convulsion

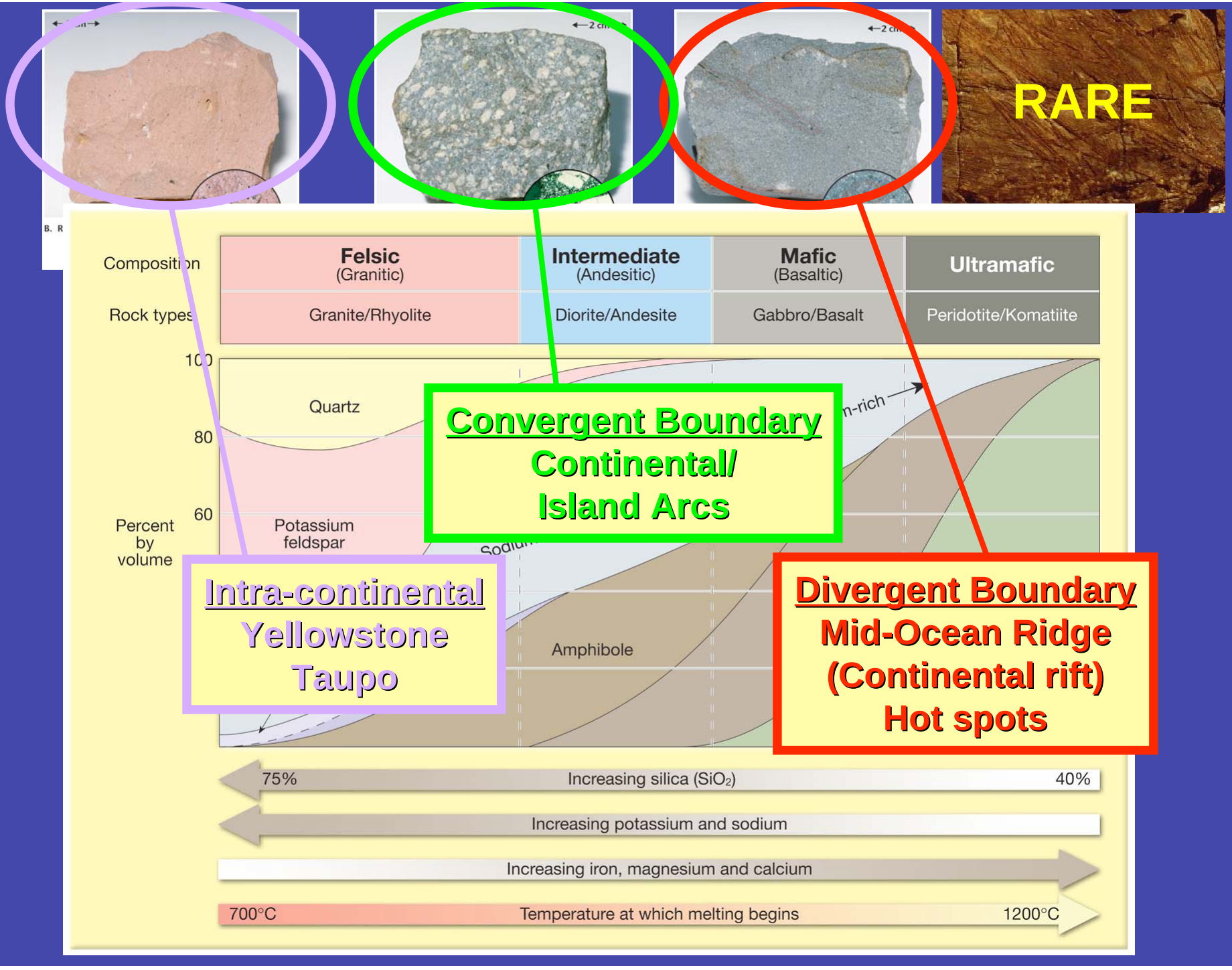

RARE
Composition
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(Granitic)
Intermediate
(Andesitic)
Mafic
(Basaltic)
Ultramafic
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60
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Potassium feldspar
Amphibole
n-rich
Convergent Boundary
Continental/
Island Arcs
Intra-continental
Yellowstone
Taupo
Divergent Boundary
Mid-Ocean Ridge
(Continental rift)
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Continental hot spots


MONTANA
Yellowstone National Park
WYOMING
1992 MAGELLA





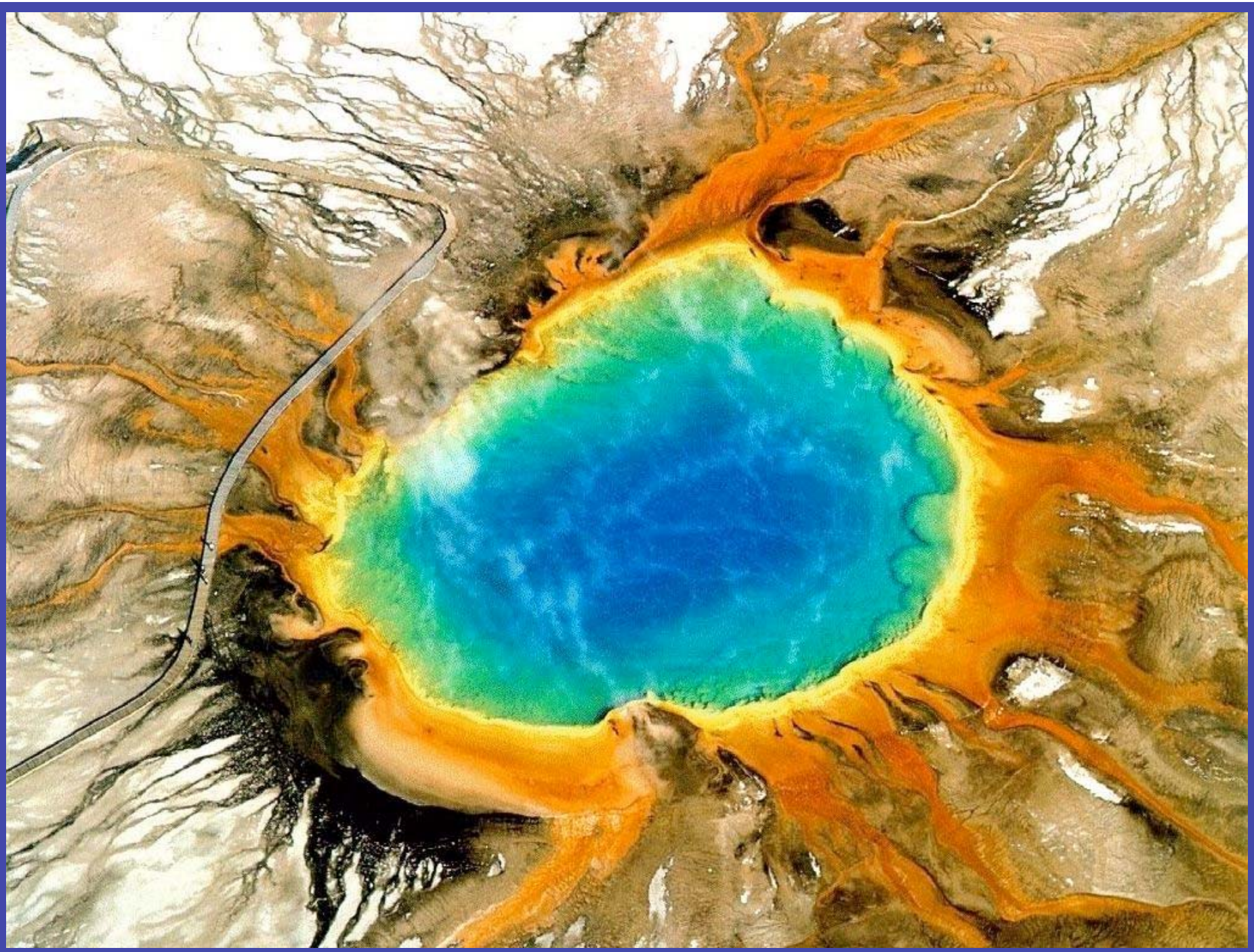








Old Faithful

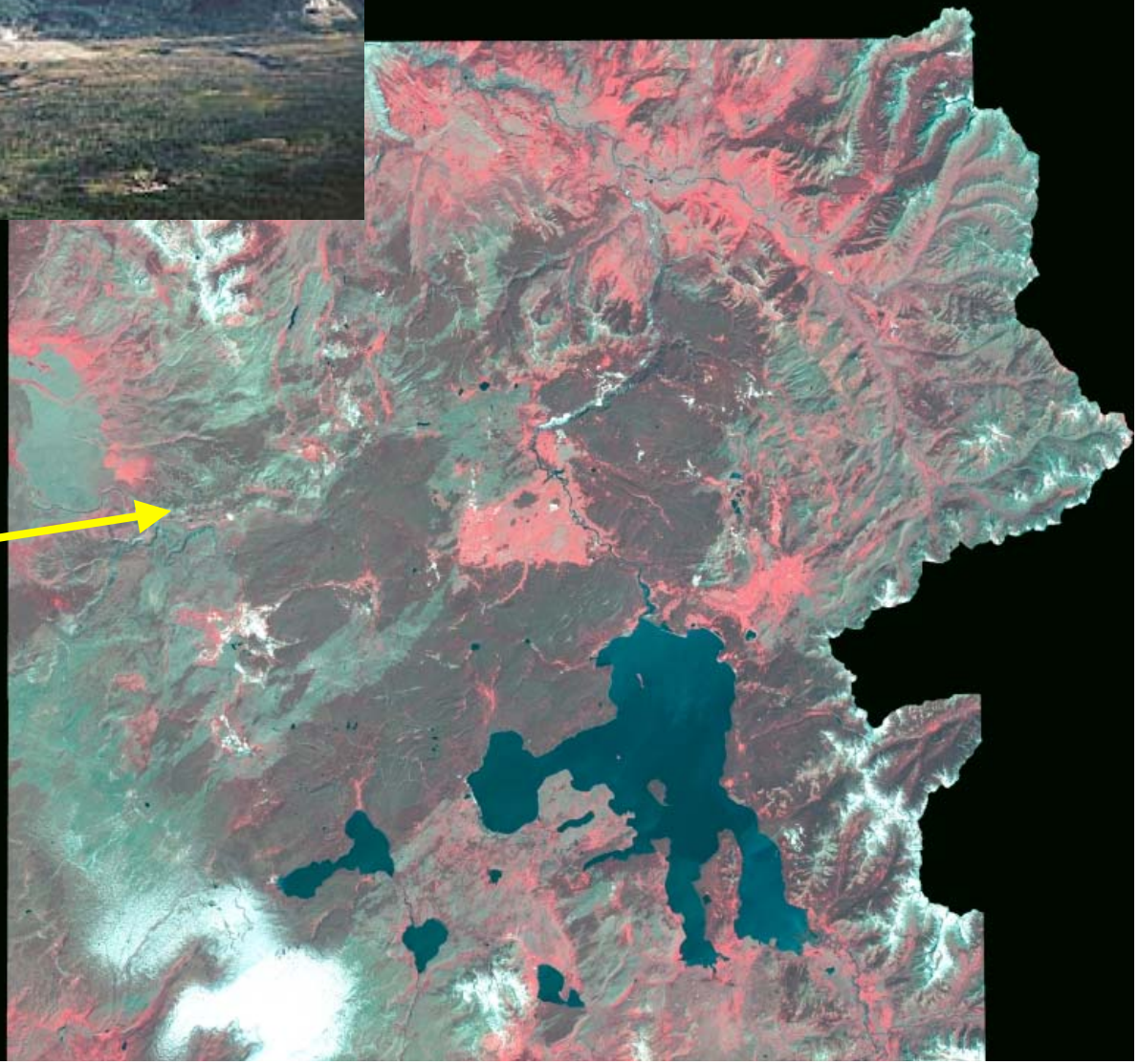


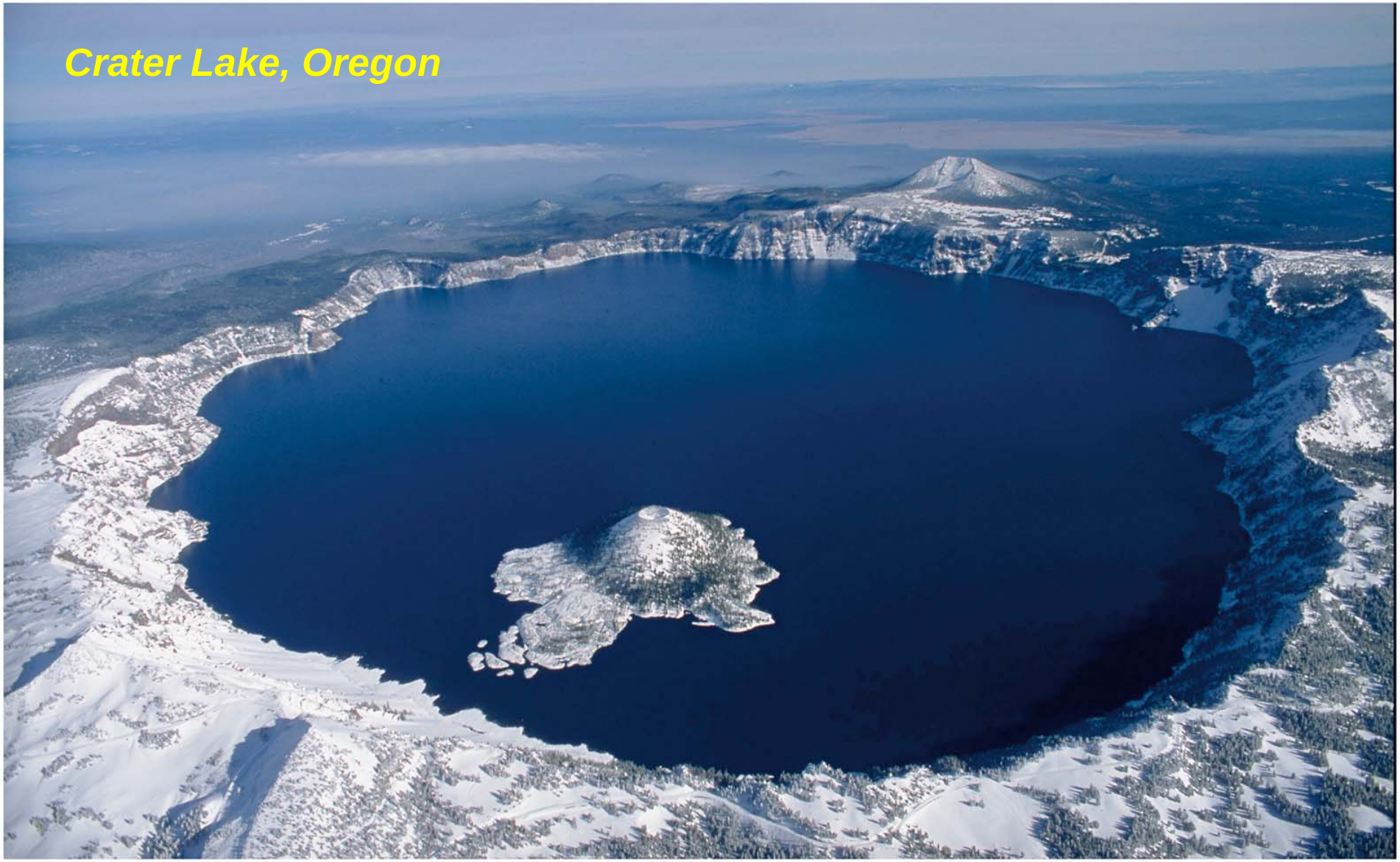


The vivid colors in the spring are the result of pigmented bacteria in the microbial mats that grow around the edges of the water. The bacteria produce colors ranging through greens, yellows, oranges, and reds; the amount of color in the microbial mats depends on the ratio of chlorophyll to carotenoids. Chlorophyll is a green photosynthetic pigment found in most plants, algae, and cyanobacteria. Carotenoids are organic pigments that are naturally occurring in plants and some other photosynthetic organisms like algae, some types of fungus and some bacteria (Wikipedia).

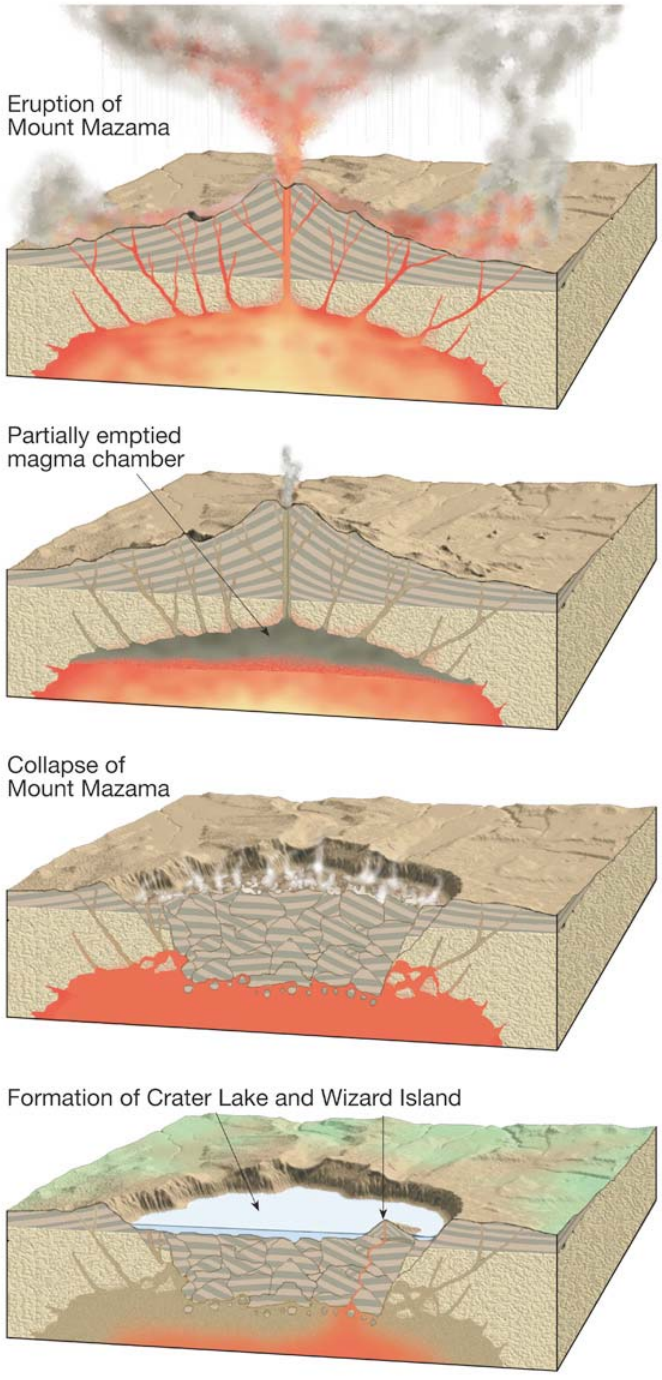


What are these cliffs?



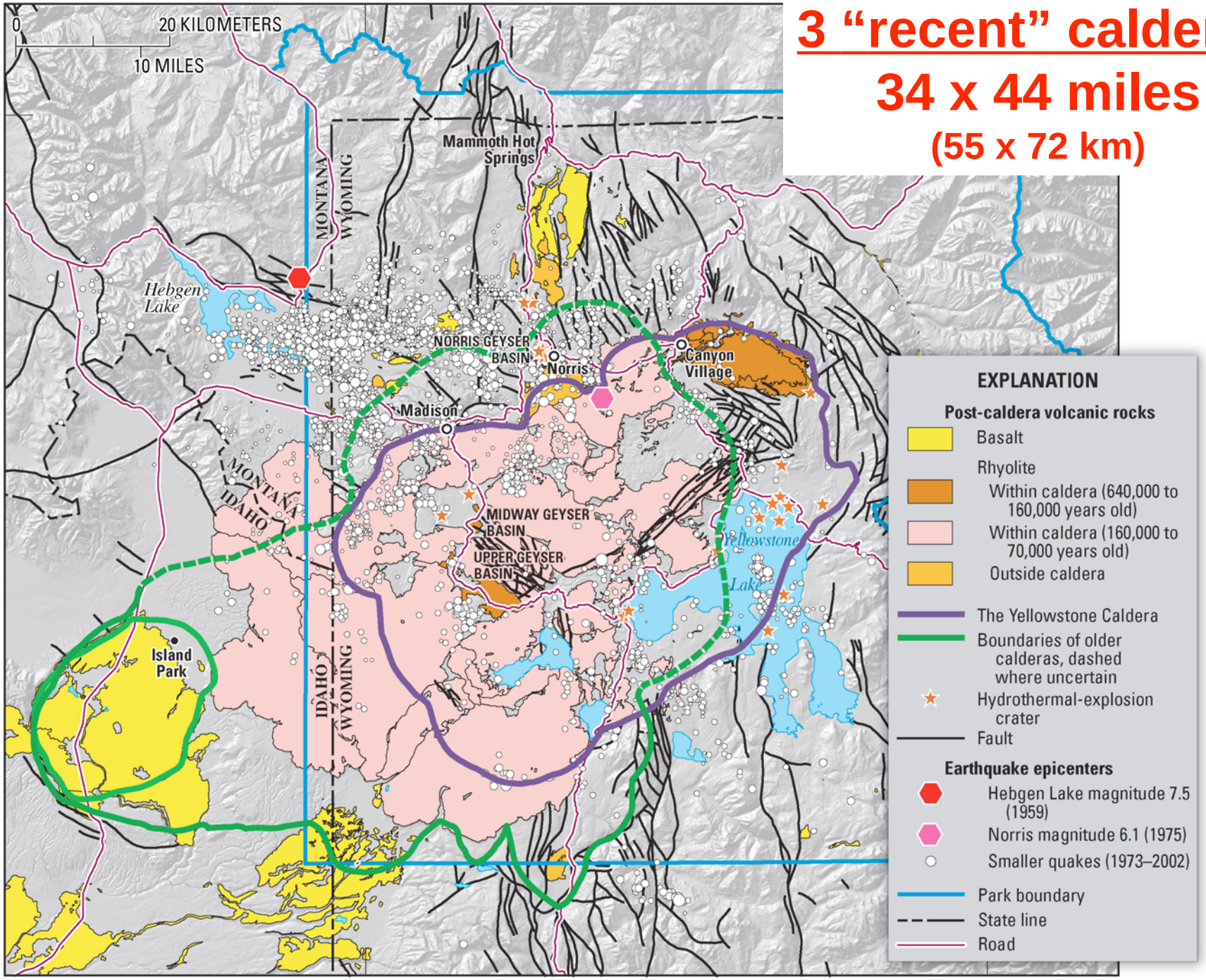


Caldera - volcanic collapse depression > 1km across





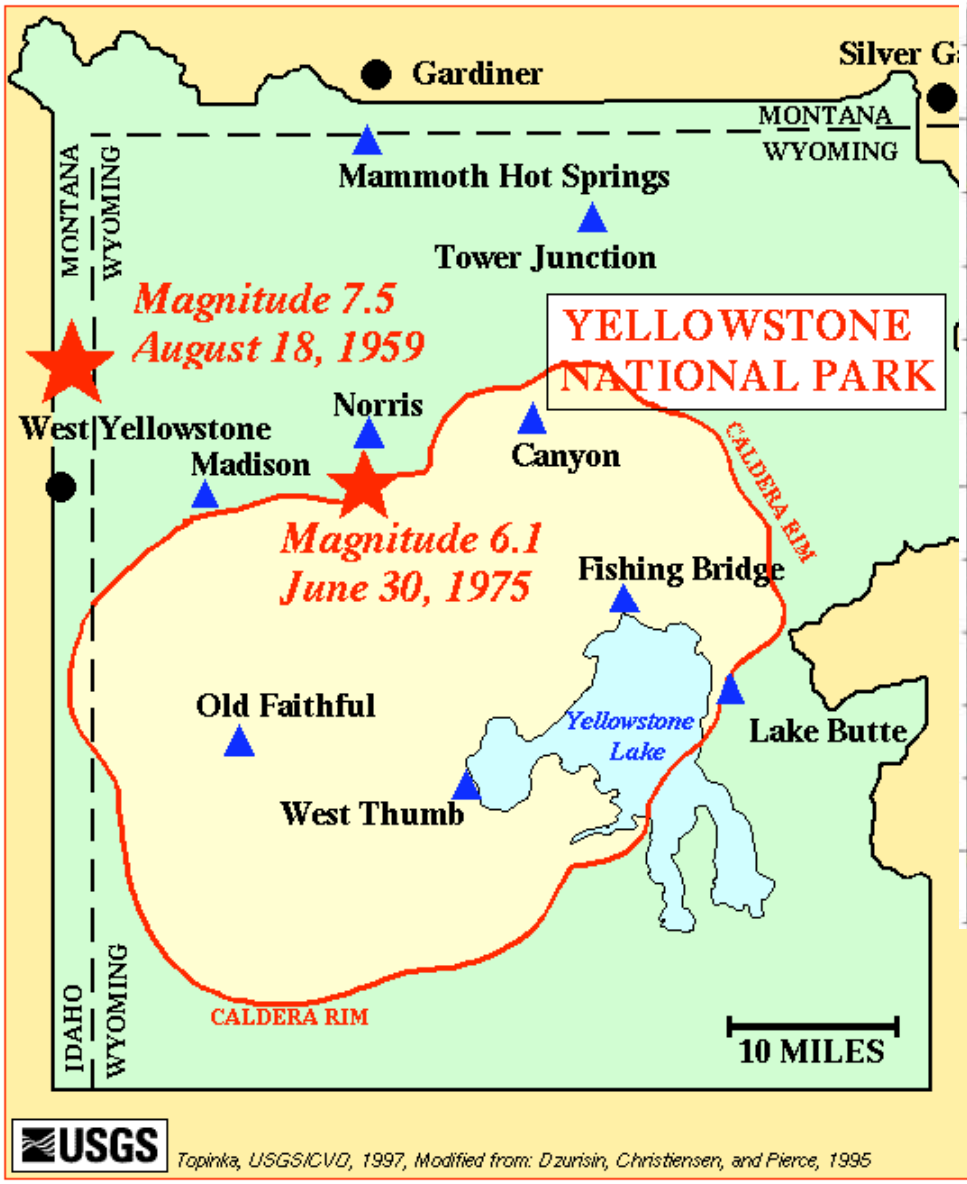
Caldera formation

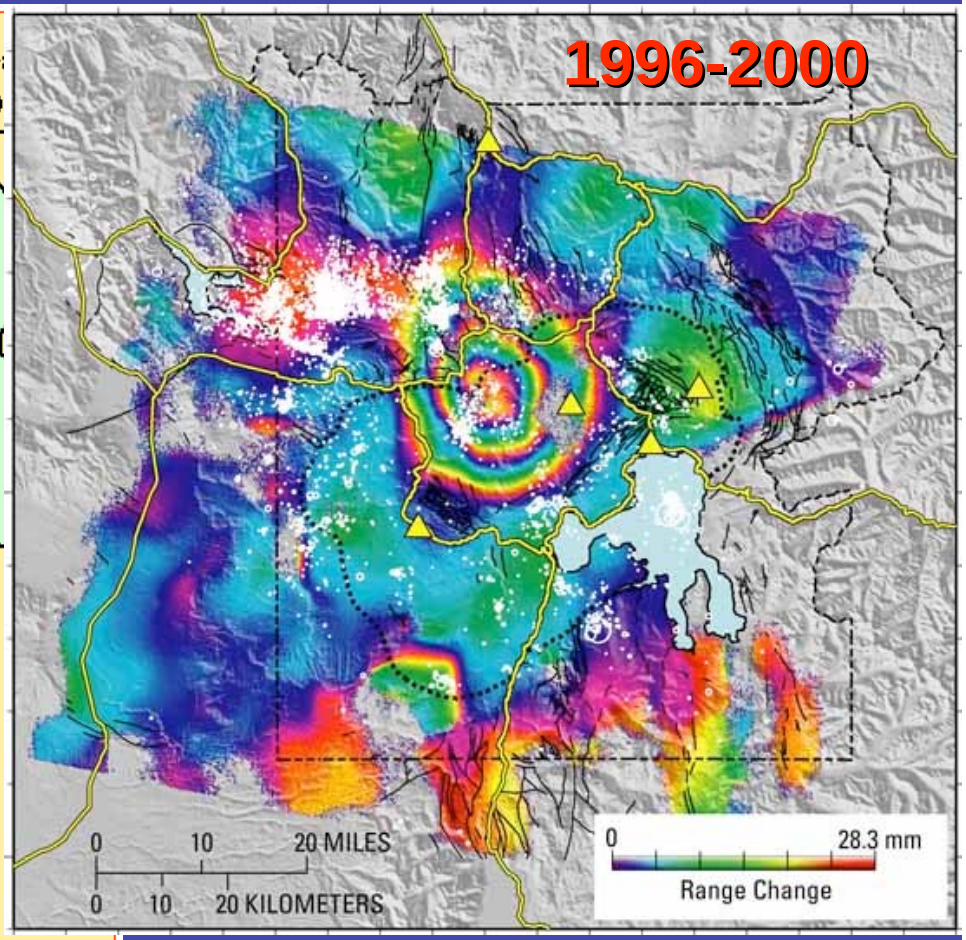


3 “recent” calderas

34 x 44 miles

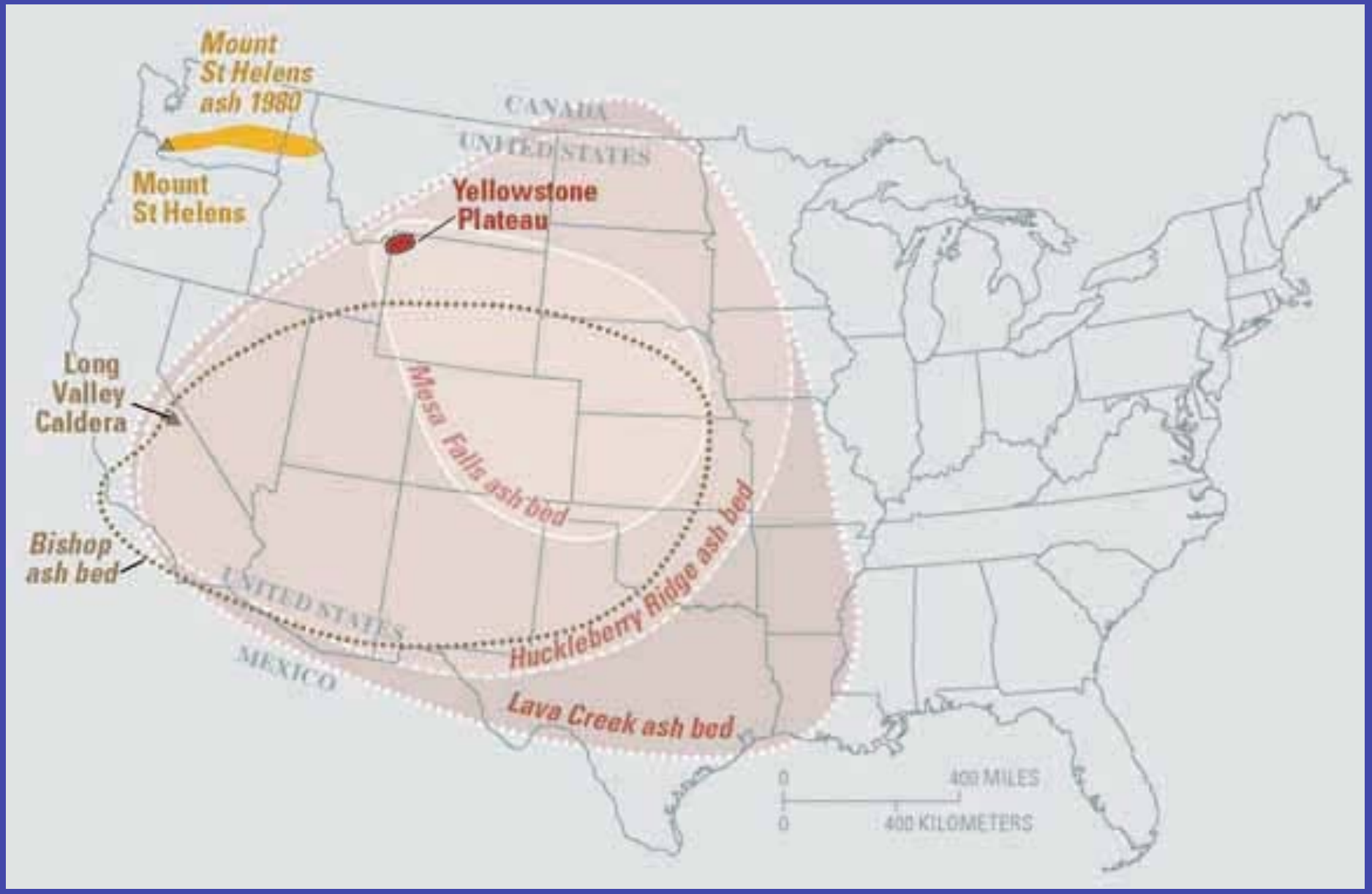
(55 x 72 km)





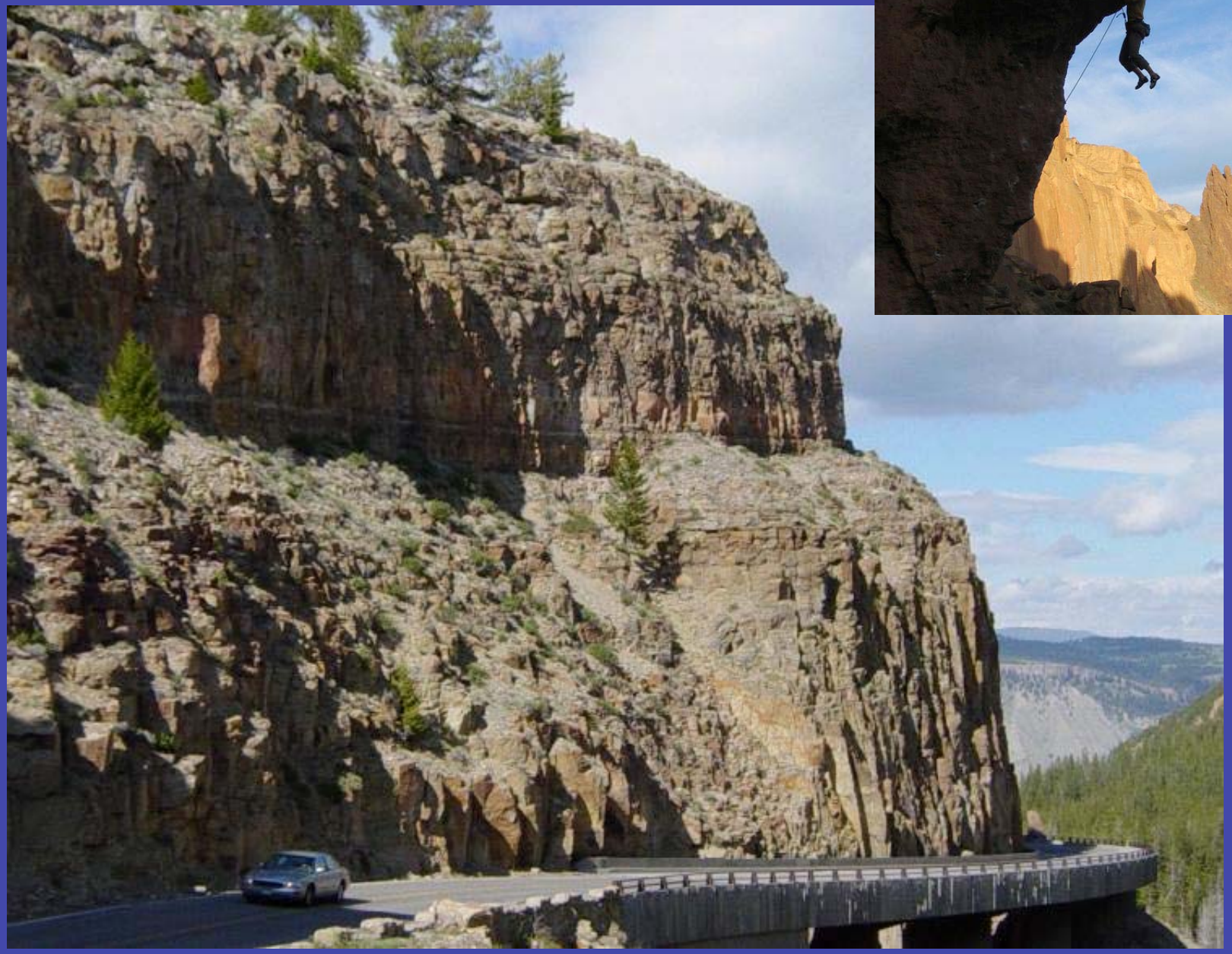


1,000-3,000 earthquakes/year


Mount
St Helens
ash 1980
Mount
St Helens
CANADA
UNITED STATES
Yellowstone
Plateau
Long
Valley
Caldera
Mesa Falls ash bed
Bishop
ash bed
Huckleberry Ridge ash bed
UNITED STATES
MEXICO
Lava Creek ash bed
0
400 MILES
0
400 KILOMETERS

Ash fall

Ignimbrites



Yellowstone volcanic features:

1) Geysers

2) Hot springs

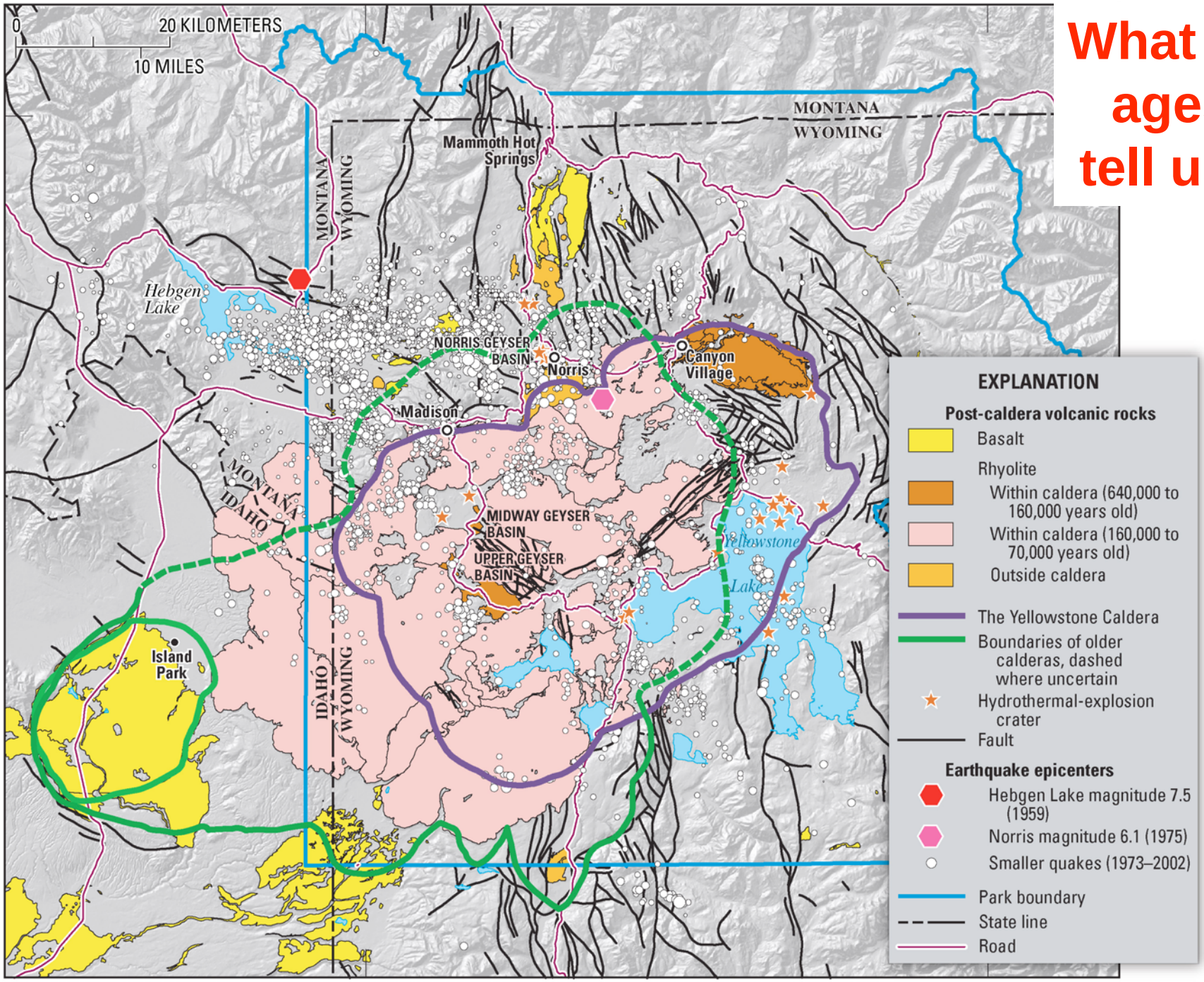
3) Caldera walls

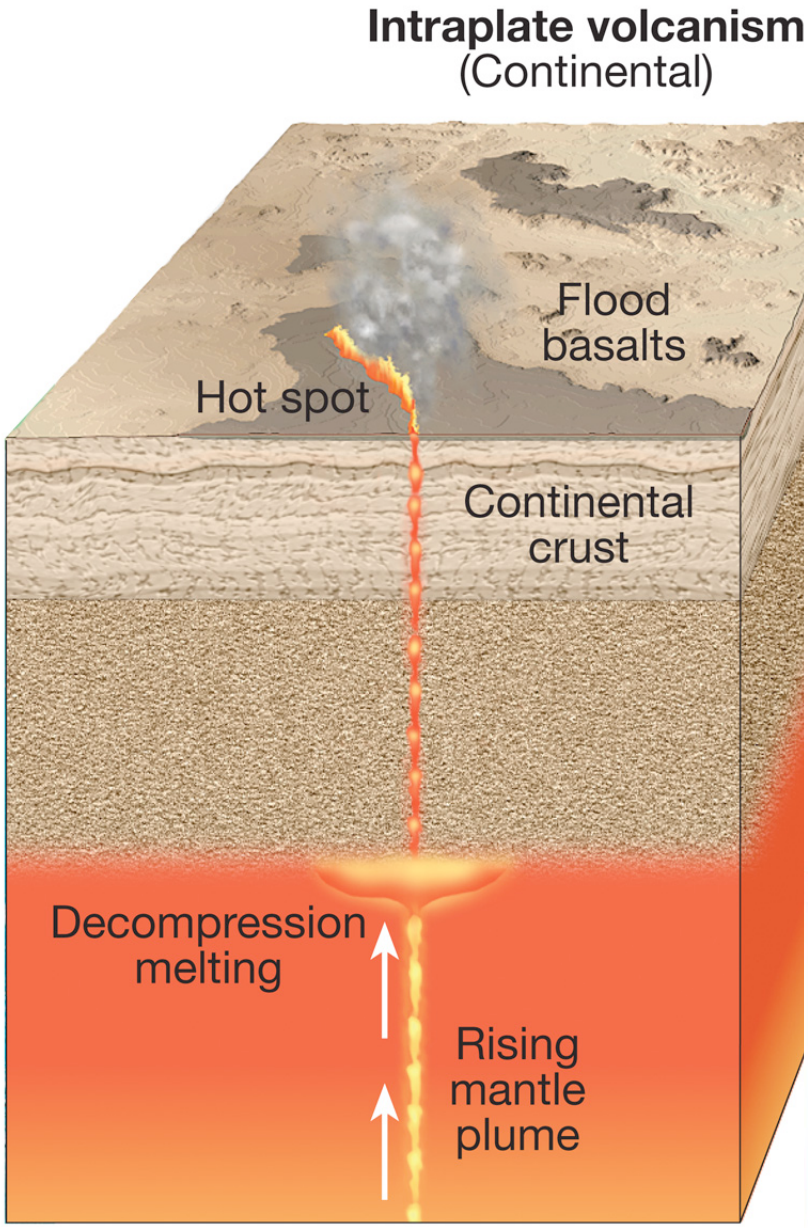
4) Earthquakes

5) Land deformation

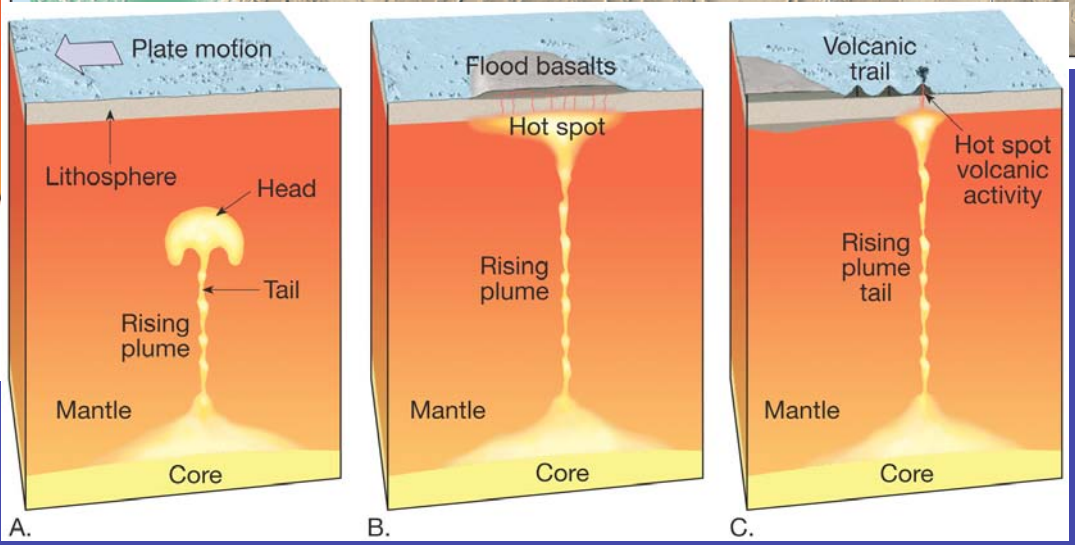
6) Ash deposits

What do ages tell us?

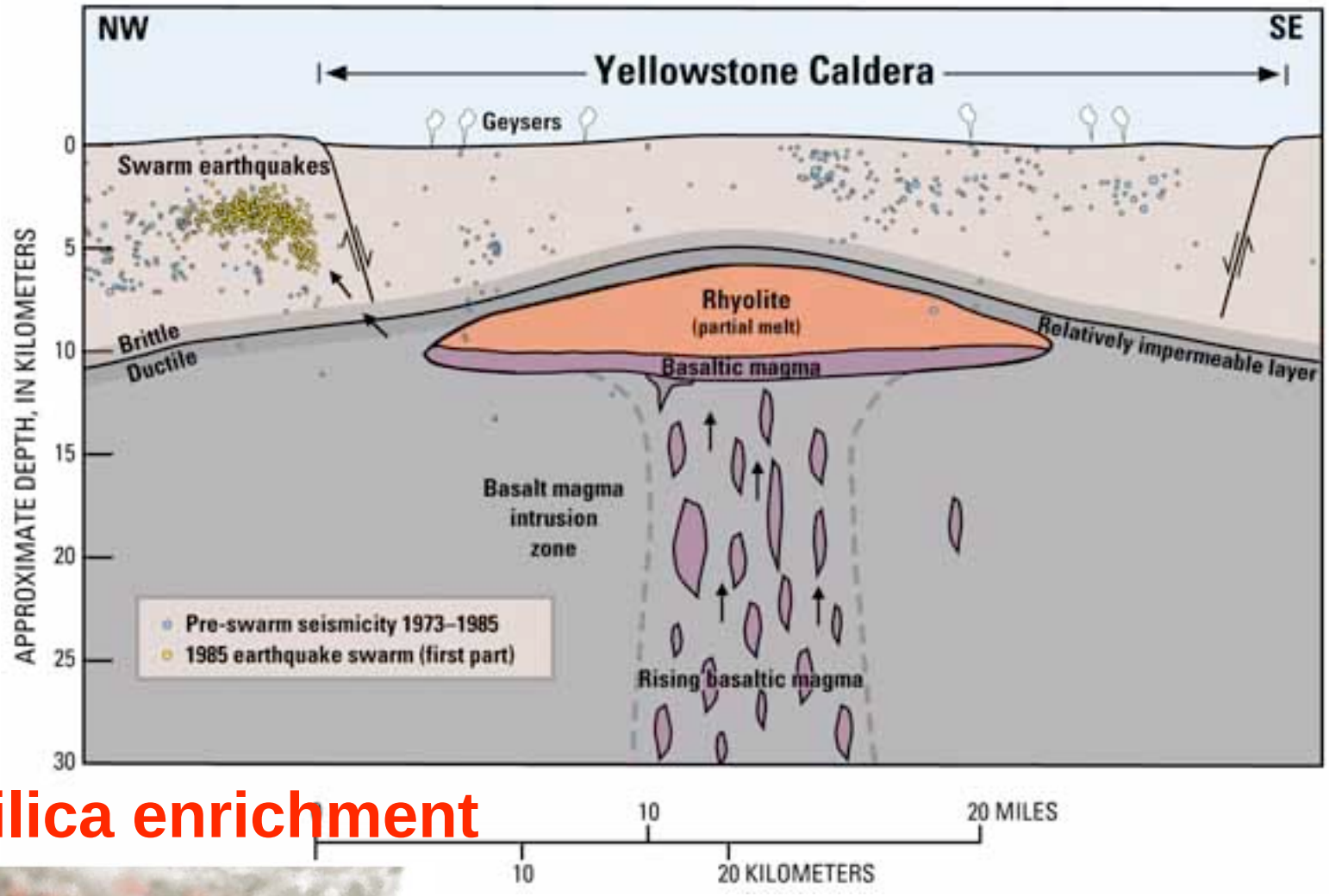




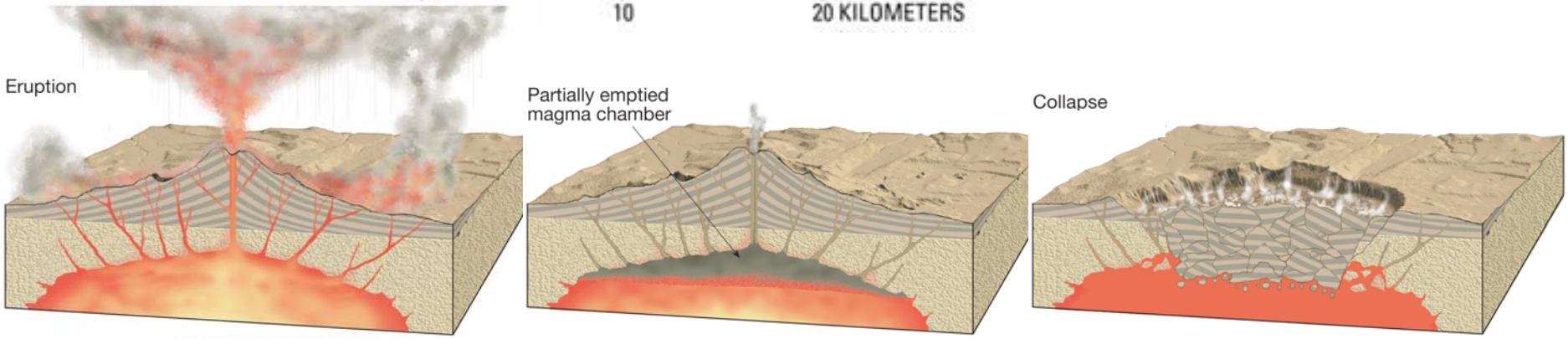


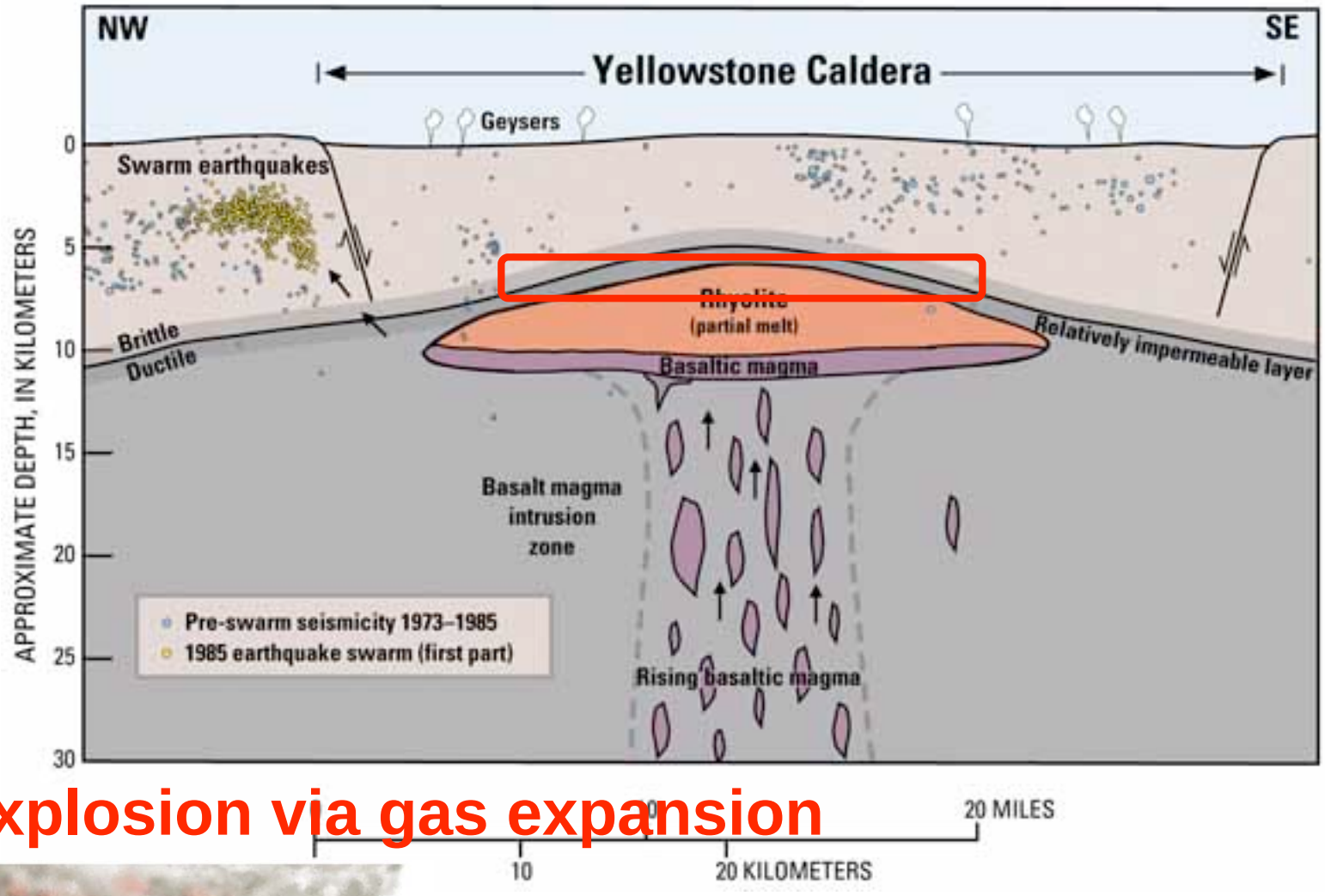


1) Hot, gaseous melt, basalt flows

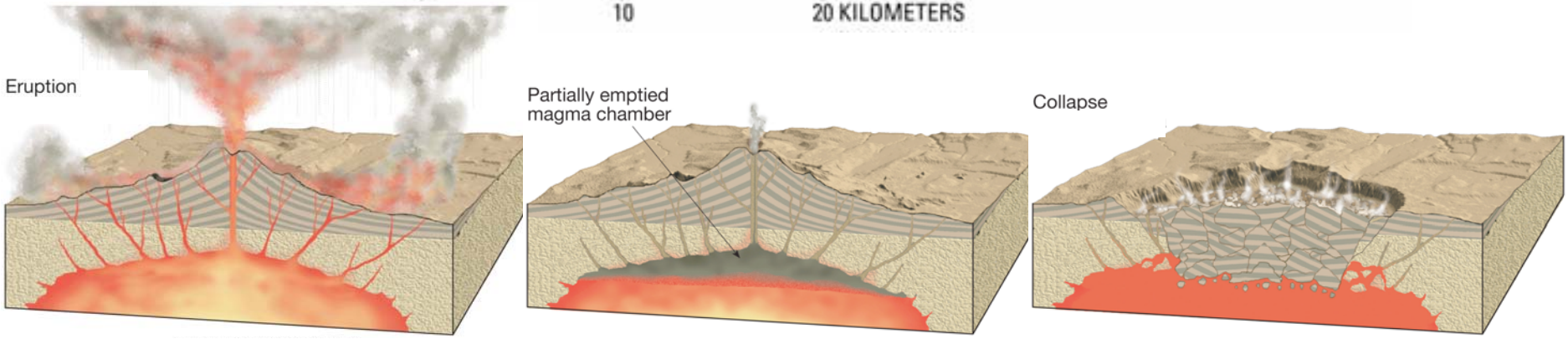


2) Silica enrichment





3) Explosion via gas expansion



Yellowstone eruptions:

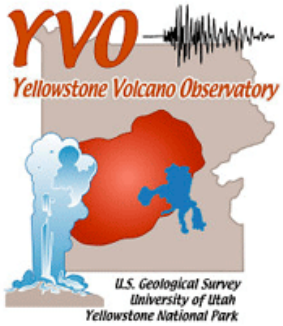
1) 2.1 million years ago
2) 1.3 million years ago
3) 640,000 years ago
4) …?

- 240 cubic miles of material erupted
- 2,500 times more powerful than St. Helens
- 12,500 atomic bombs
- millions of deaths locally
- catastrophic climatic effects globally

When will Yellowstone erupt again?

yearly probability of
1 in 730,000 or 0.00014%

roughly similar to that of a large
(1 kilometer) asteroid hitting the Earth



Yellowstone Monthly Activity Update — Each update is compiled for the previous month and posted in the first week of the new month.

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Saturday, September 2, 2006 23:04  MDT
Current Volcanic-Alert Level: NORMAL
Current Aviation Color Code: GREEN

August 2006 Yellowstone Seismicity Summary

During August, 2006, 82 earthquakes were located in
the Yellowstone region.  The largest of these shocks
was a magnitude 2.7 on August 9, 2006 at 7:34 AM MDT,
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The Yellowstone Volcano Observatory (YVO) was created as a partnership among the U.S. Geological Survey (USGS), Yellowstone National Park, and University of Utah to strengthen the long-term monitoring of volcanic and earthquake unrest in the Yellowstone National Park region. Yellowstone is the site of the largest and most diverse collection of natural thermal features in the world and the first National Park. YVO is one of the five USGS Volcano Observatories that monitor volcanoes within the United States for science and public safety.

New article on monitoring supervolcanoes published in The Royal Society of London volume on Extreme Natural Hazards

07/24/2006

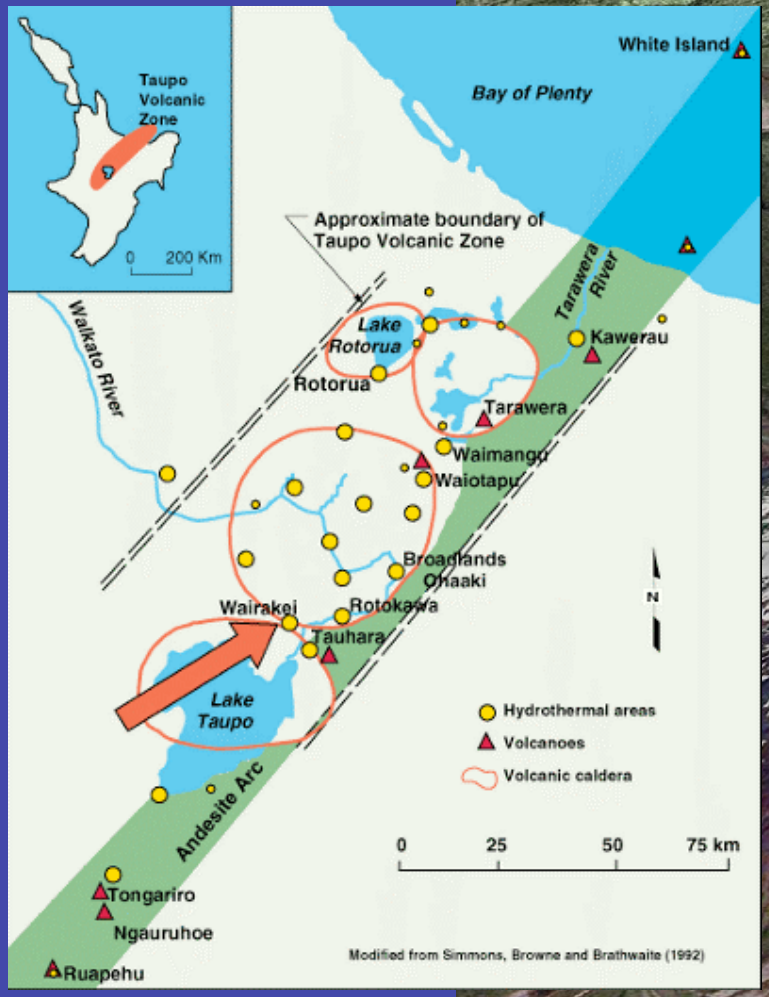
YVO coordinating scientists Jacob Lowenstern and Robert Smith together with Long Valley Scientist-in-Charge David Hill recently published an article, Monitoring super-volcanoes: geophysical and geochemical signals at Yellowstone and other large caldera systems", that summarizes current knowledge about monitoring geological unrest at large calderas such as Yellowstone. The article is part of a group of papers that formed a Discussion Meeting on Extreme Natural Hazards organized through the Royal Society of London in October 2005. For more information about other papers from the meeting, please see the Royal Society Publishing Web site.

American Museum of Natural History's New Web Page on Yellowstone Featuring Interviews and Articles with YVO Scientists

07/03/2006

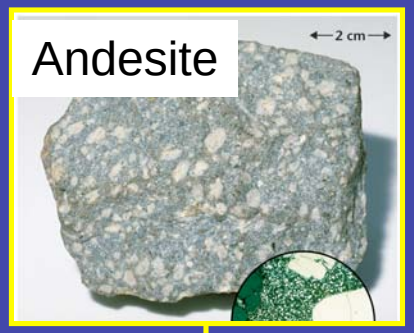
The American Museum of Natural History joined Yellowstone Volcano Observatory scientists in the field last September (2005) and have just posted a video, articles, and two interactive slide shows about the geology of the area. The video, *Yellowstone: Monitoring the Fire Below* includes interviews with Jake Lowenstern, YVO's Scientist-in-Charge, Hank Heasler, YVO Coordinating Scientist and Yellowstone Park Geologist, and USGS geologist Lisa Morgan. The articles, *Yellowstone National Park is a Volcano* and *Signs of Restlessness* expand on the information in the video whereas the article, *Volcanic Witness: An Interview with Bob Smith* provides information from Bob Smith's, YVO's Coordinating Scientist from the University of Utah, four decades of work on Yellowstone. For more information and to view the video, please see American Museum of Natural History Science Bulletins, Yellowstone: Monitoring the Fire Below.

Internet
Microsoft PowerPoint ...
Yellowstone Volcano ...
Search with Google
10:11 A



Taupo Volcanic Zone







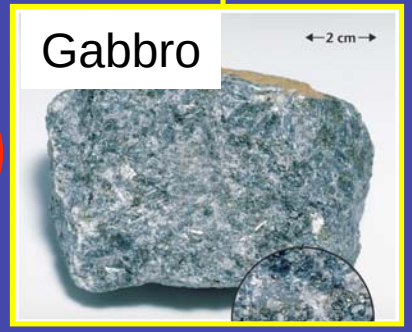


Extrusive: erupted at Earth's surface
Generally relatively fine-grained

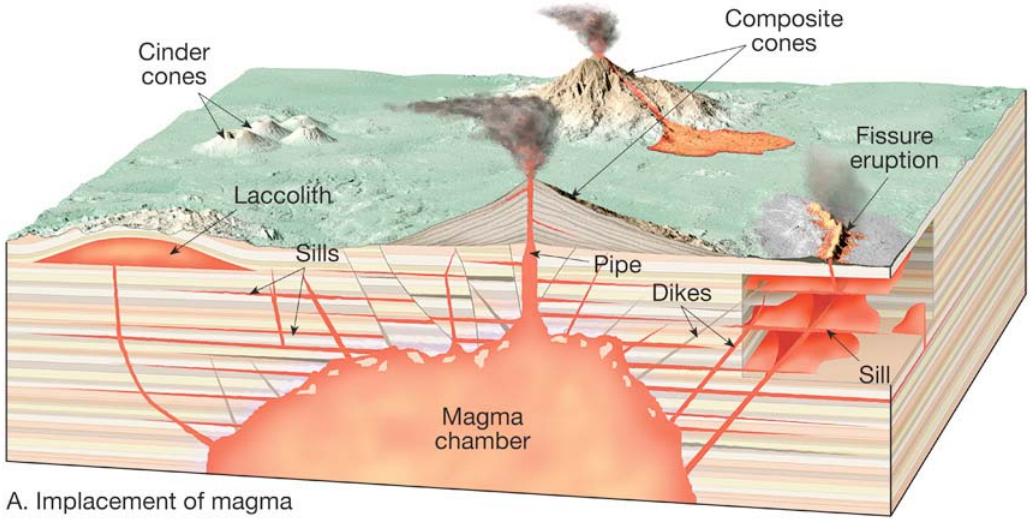
Intrusive: never erupted
Generally relatively coarse-grained



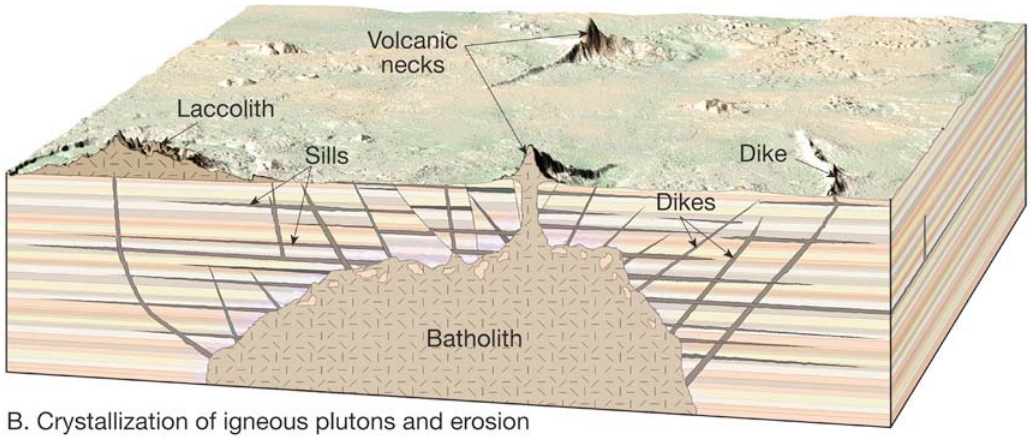




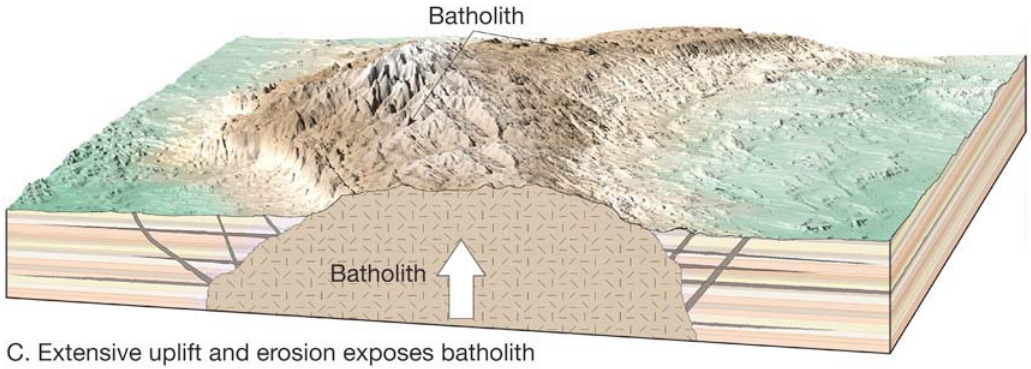




A. Implacement of magma



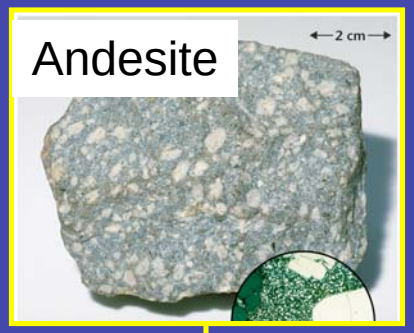
B. Crystallization of igneous plutons and erosion



C. Extensive uplift and erosion exposes batholith







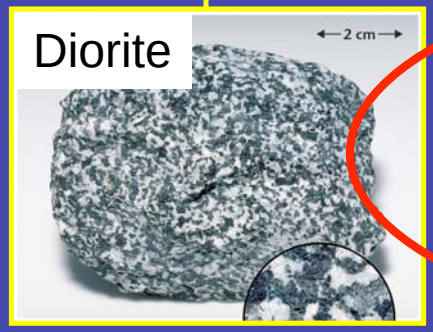




Extrusive: erupted at Earth's surface
Generally relatively fine-grained

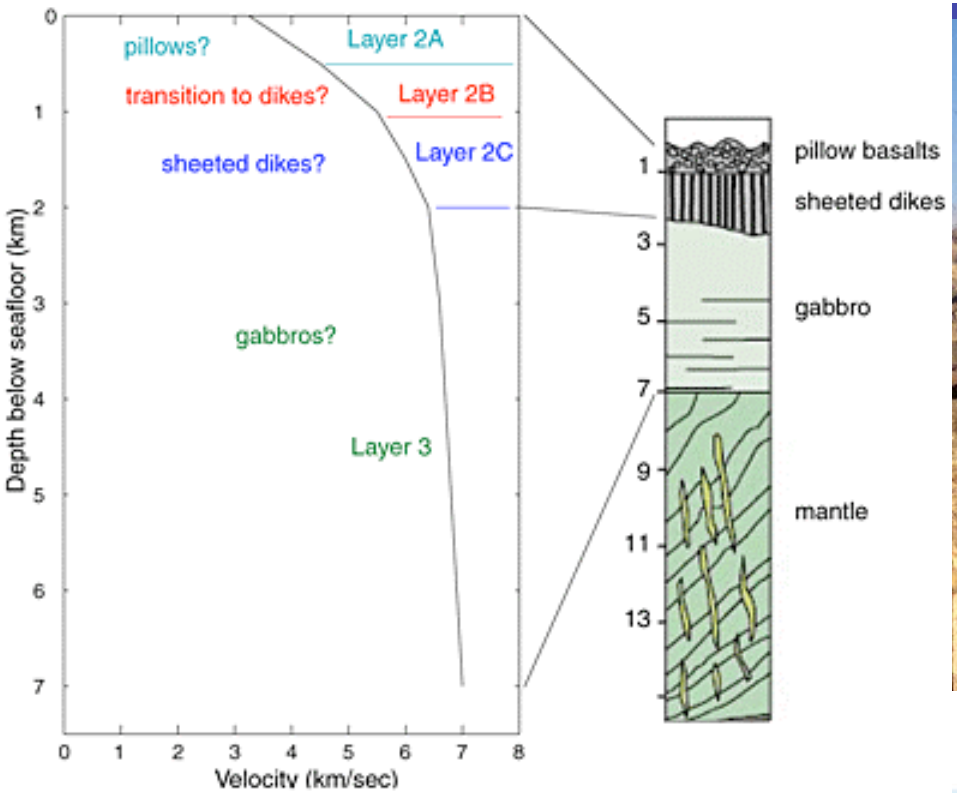
Intrusive: never erupted
Generally relatively coarse-grained





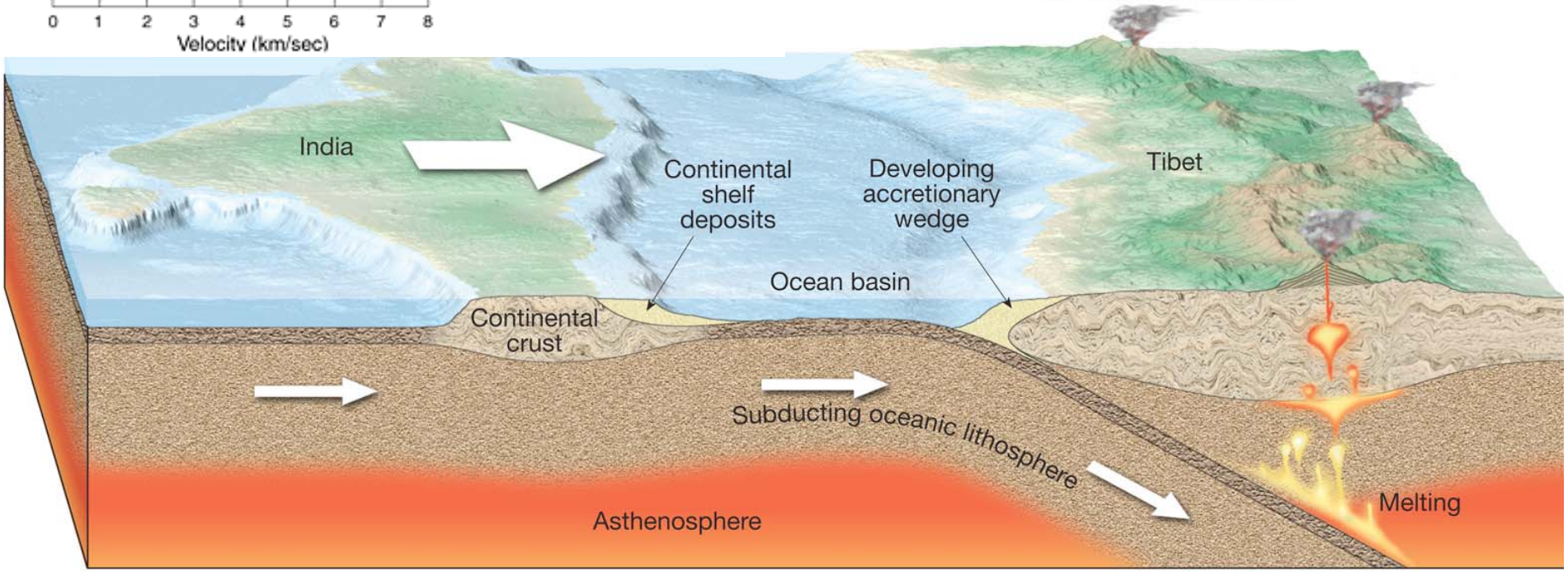








Continental volcanic arc



Divergent / oceanic hot spots

- basaltic, low profile
- low explosivity
- intrusives: ophiolite sequences

Convergent

- andesitic, composite cones
- explosive
- intrusives: batholiths

Intra-continental volcanism (hot spots / zones)

- multi-stage: 1) basalt, 2) rhyolite
- calderas
- highly explosive
- intrusives: batholiths