Interpreting the Geologic Story of Craters of the Moon and How EarthScope Can Help

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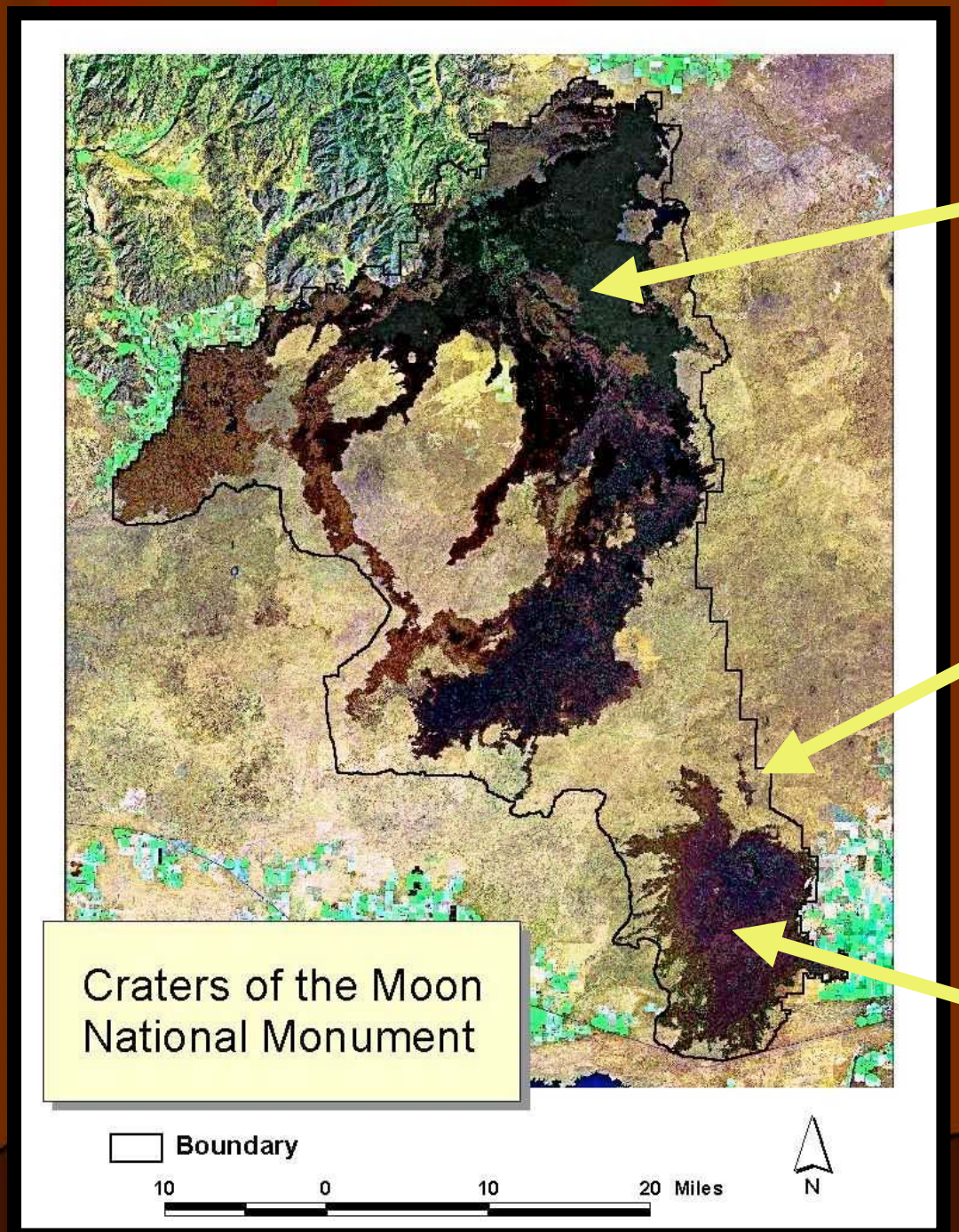


Craters of the Moon Lava Field (618 sq. miles) is the largest geologically young basaltic lava field in the lower 48 states.

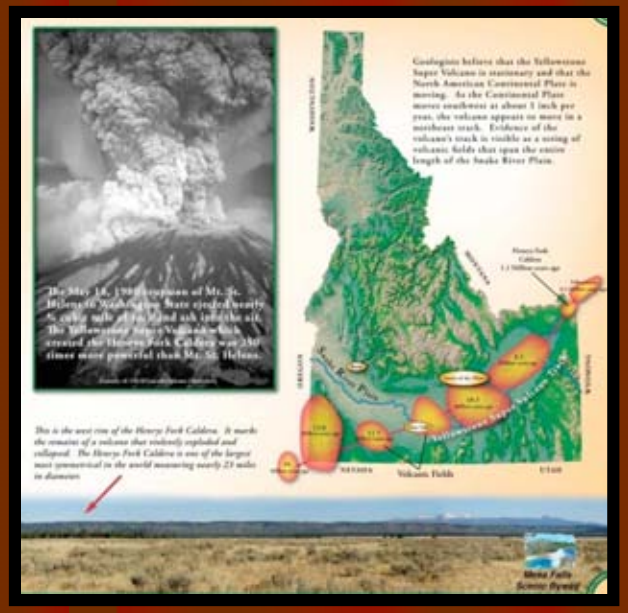
Kings Bowl Lava Field

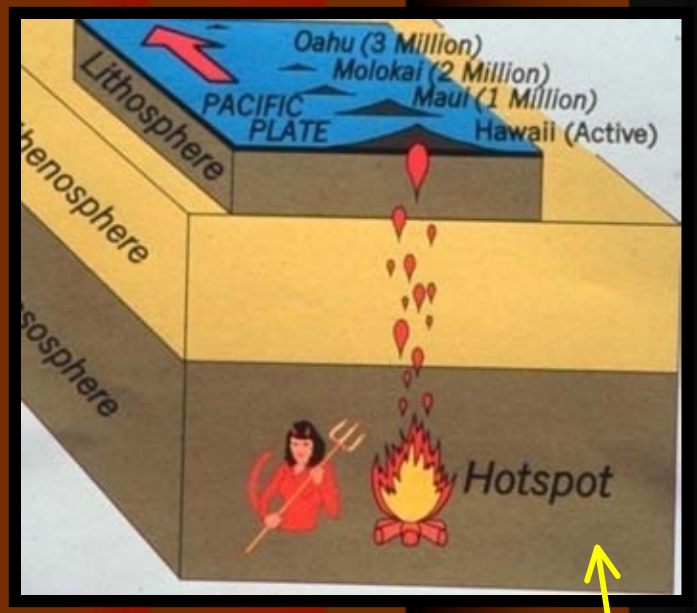
(This segment of the Great Rift is the deepest open volcanic rift on earth!)

Wapi Lava Field

Big Picture = the track of the Yellowstone Hotspot & Basin and Range Extension.

Idaho



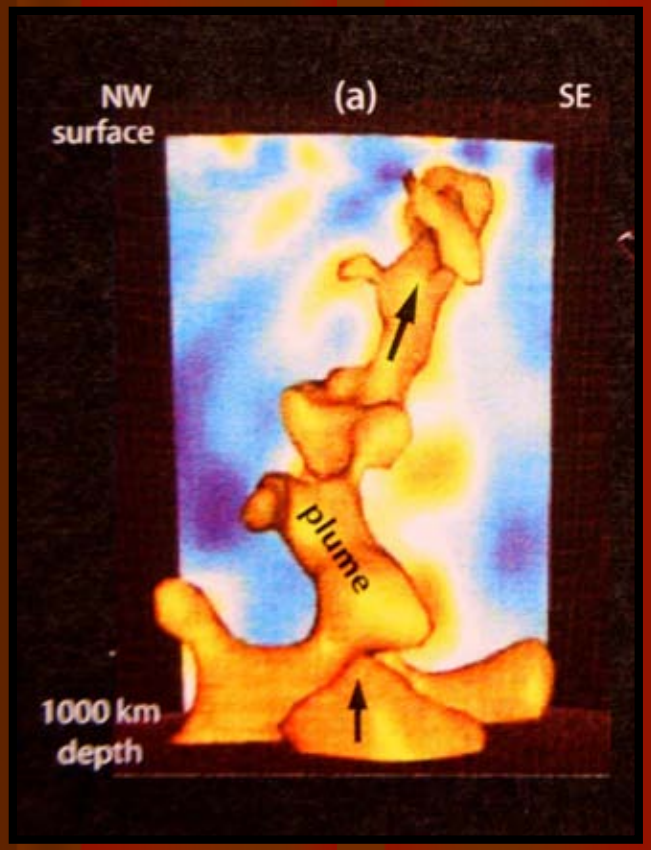


Hawaii

Bob Lillie diagram

How could EarthScope help?

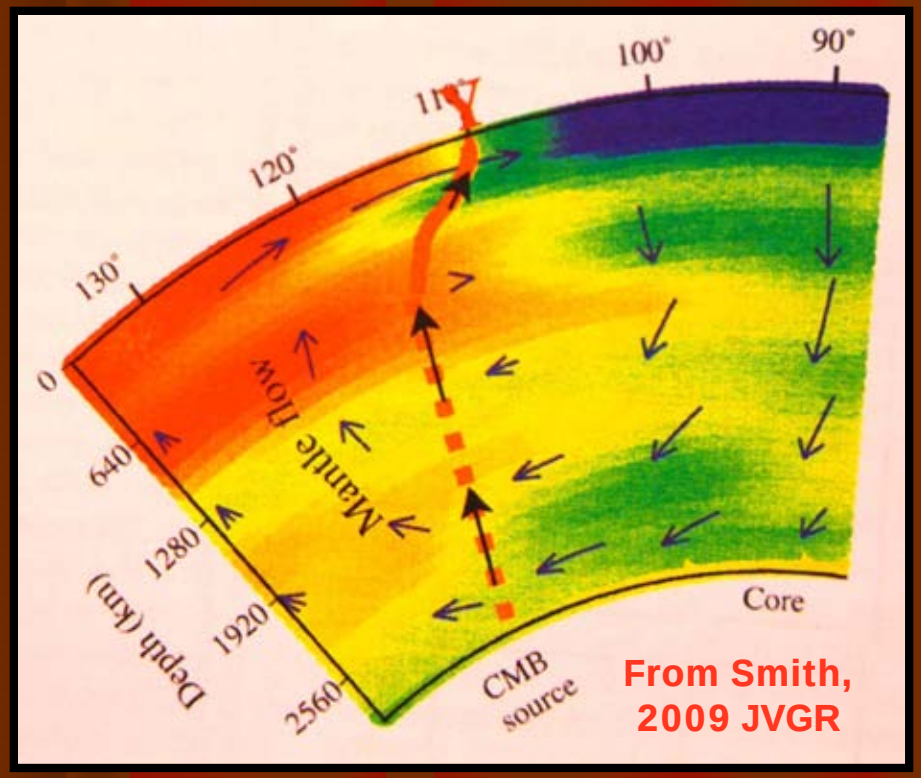
- Animations and figures of Hawaii and Yellowstone hotspot tracks



The Yellowstone Hotspot Plume has now been imaged to a depth of 1,000 km (~600 miles) and it dips down at an angle of 60^0 to the NW. How much further down it goes, waits to be learned.

Image from Allen 2009 in Grand Challenges of Seismology

EarthScope can keep the images coming and make them readily available.

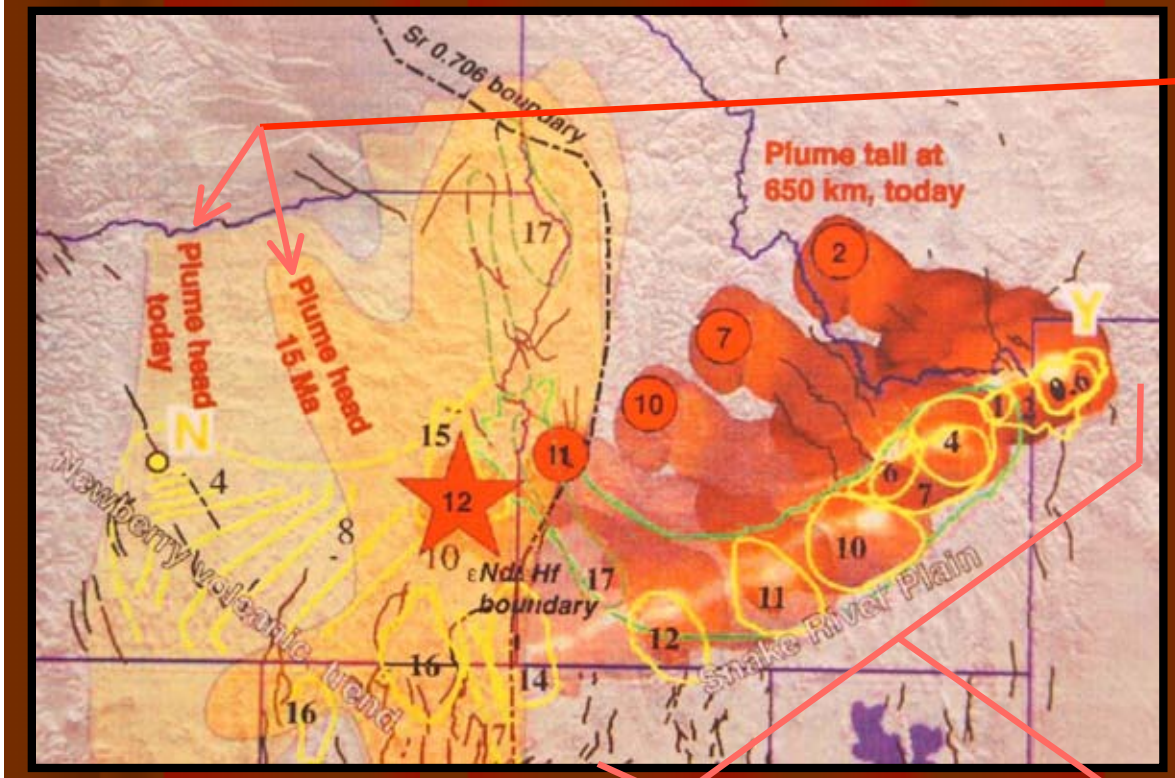


Plume is believed to be deflected by mantle flow (Smith, 2009)

Smith says, "the amount of observed tilt can be better matched with our models by having the plume originate in the lower mantle."

"Computed upper mantle flow in the vicinity of Yellowstone is eastward. This eastward flow is part of a large-scale convection cell upwelling beneath the Pacific Ocean and downwelling beneath the central and eastern U.S." (Smith, 2009)

How about an EarthScope Animation?



“ The original voluminous plume head rose vertically from the deep mantle and became entrained in the westward return flow driven by the eastward subduction of the Juan de Fuca plate. The relatively weaker and thinner oceanic lithosphere allowed the plume head to spread out and protected the plume from the eastward currents…”

“As the North American plate progressed southwest it encountered the much thicker continental lithosphere and lost the protection of the back-arc geometry from large-scale mantle flow.”

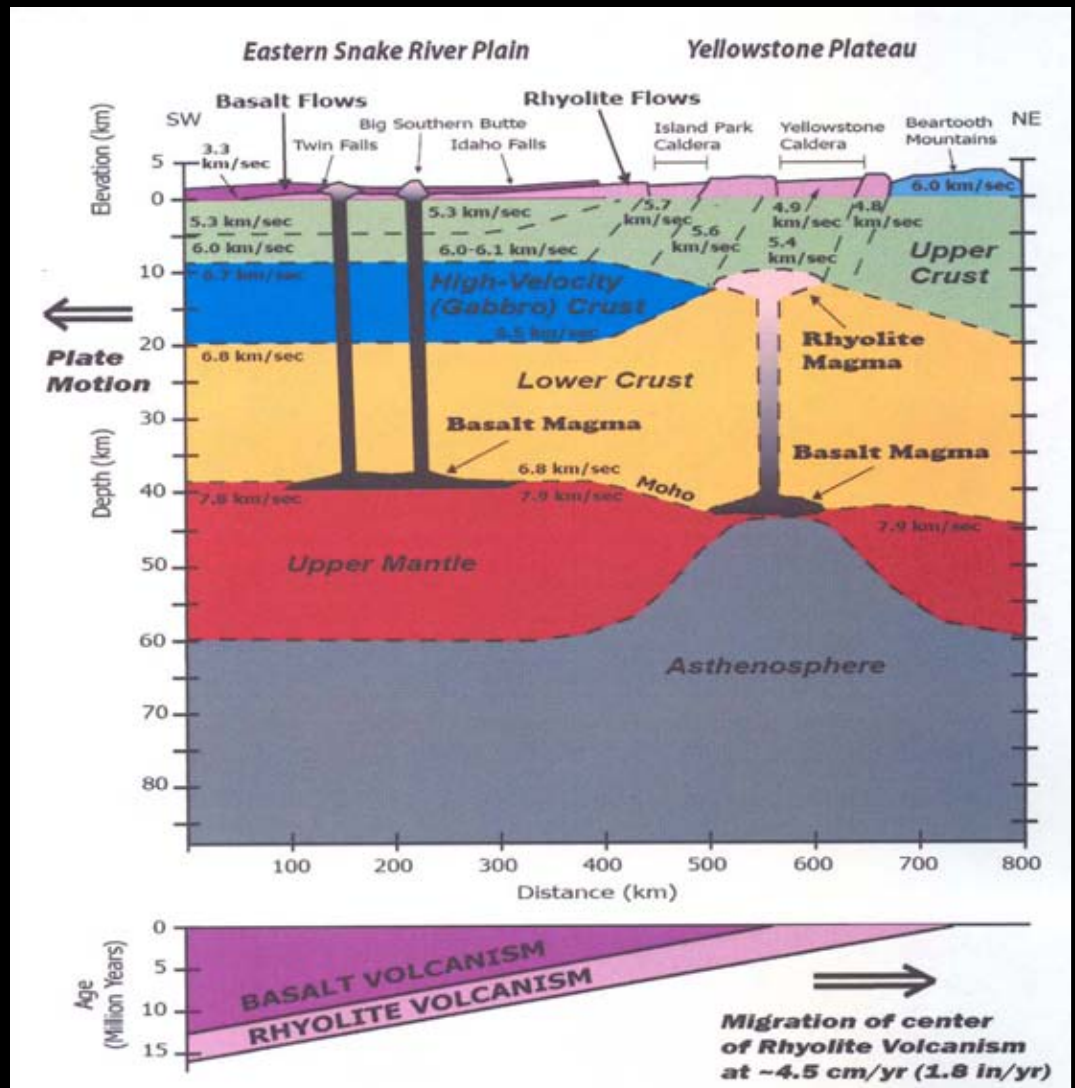
EarthScope Animation?

Interpretation from Bob Smith 2009, Journal of Volcanology and Geothermal Research

In the wake of the Yellowstone Hotspot a lot of hot rocks were left behind.

When the crust is stretched and the pressure relieved these very hot rocks can become molten again.

New EarthScope diagram(s) or animation?

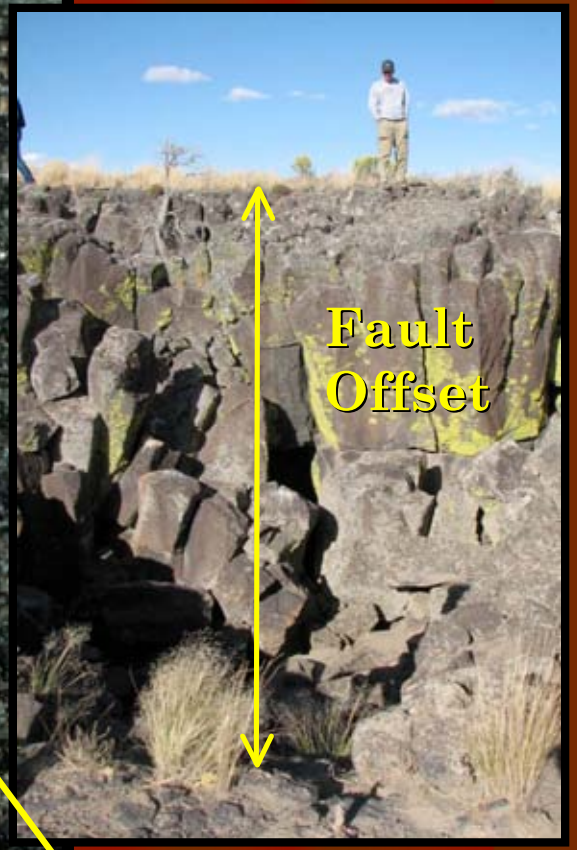


From Truitt & Lillie, 2007

Figure 2.14. Results of seismic velocity studies, adapted from Smith and Braile (1993), plotted as a cross section along the axis of the Eastern Snake River Plain southwest to northeast from Twin Falls, Idaho to the Yellowstone Plateau (location in Figure 2.1). The lower diagram shows that rhyolite volcanic deposits beneath the ESRP are progressively younger toward the Yellowstone Plateau, and that overlying basalt flows are found along the entire length of the eastern SRP.

Faults & Rifts

Faults have offset



Dick's Fissure

Great Rift,
a volcanic rift

Volcanic rifts usually have little or no vertical offset.

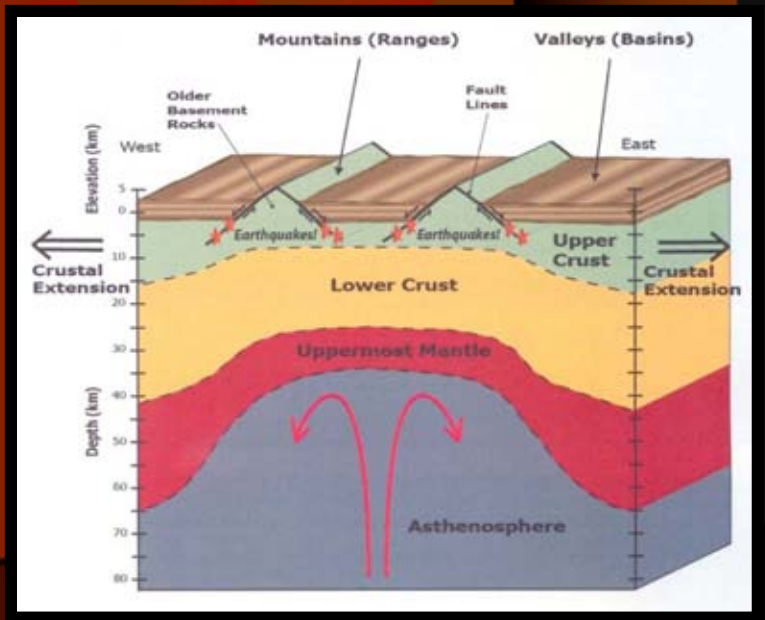
Faults & Rifts Cont.

Highway Fault

This fault scarp is believed to be the result of collapse back into the magma chamber after magma withdrawal.

Basin and Range type faulting is stretching the crust in Craters of the Moon and the surrounding area.

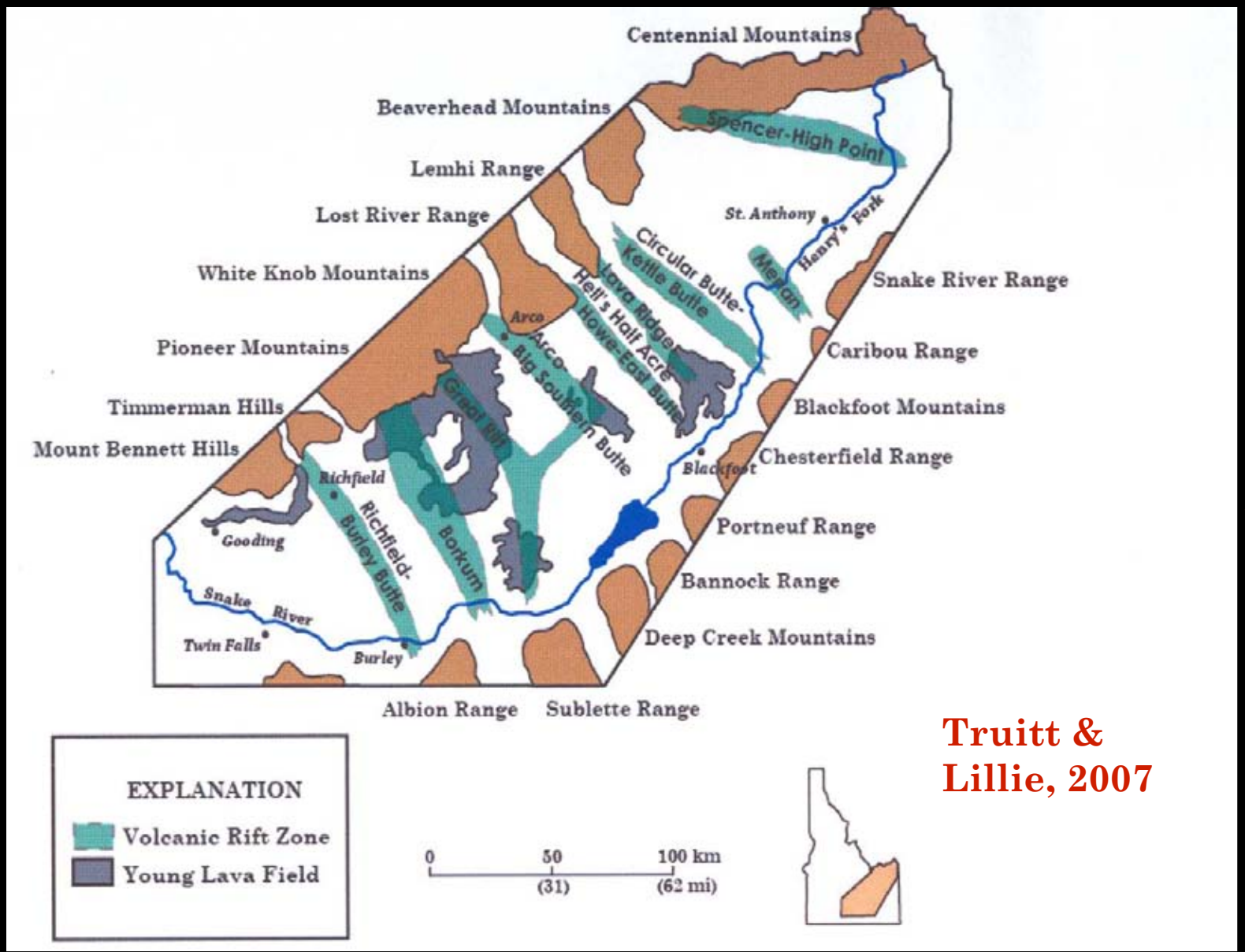
Death Valley may some day look like the Red Sea when the Gulf of California opens up into it.



New EarthScope diagrams or animations?

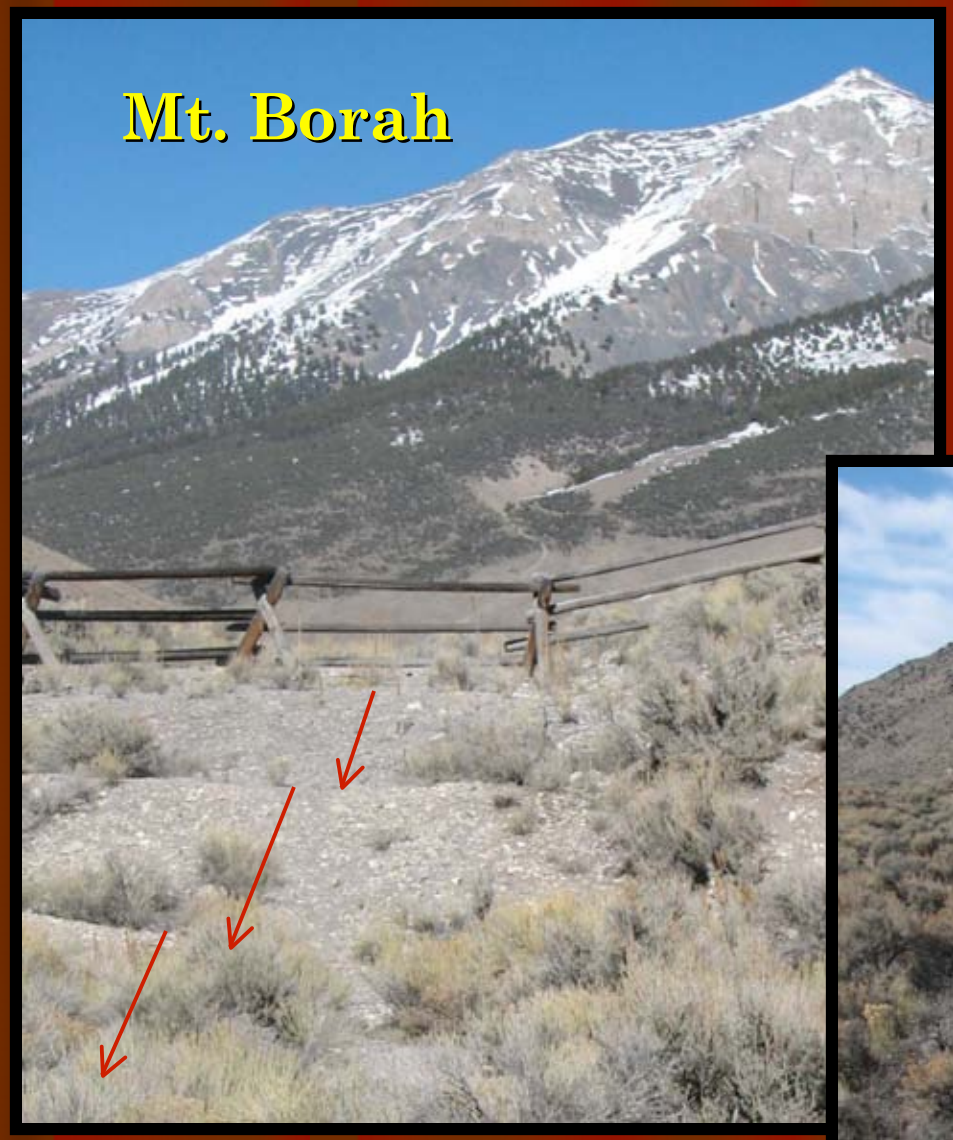
Figures from *Parks and Plates* By Bob Lillie, 2005 and training manual by Truitt & Lillie, 2007

Mountain ranges and volcanic rifts caused by Basin and Range Extension have similar orientations.



Truitt & Lillie, 2007

New Earth-Scope Diagram on a Satellite Image?

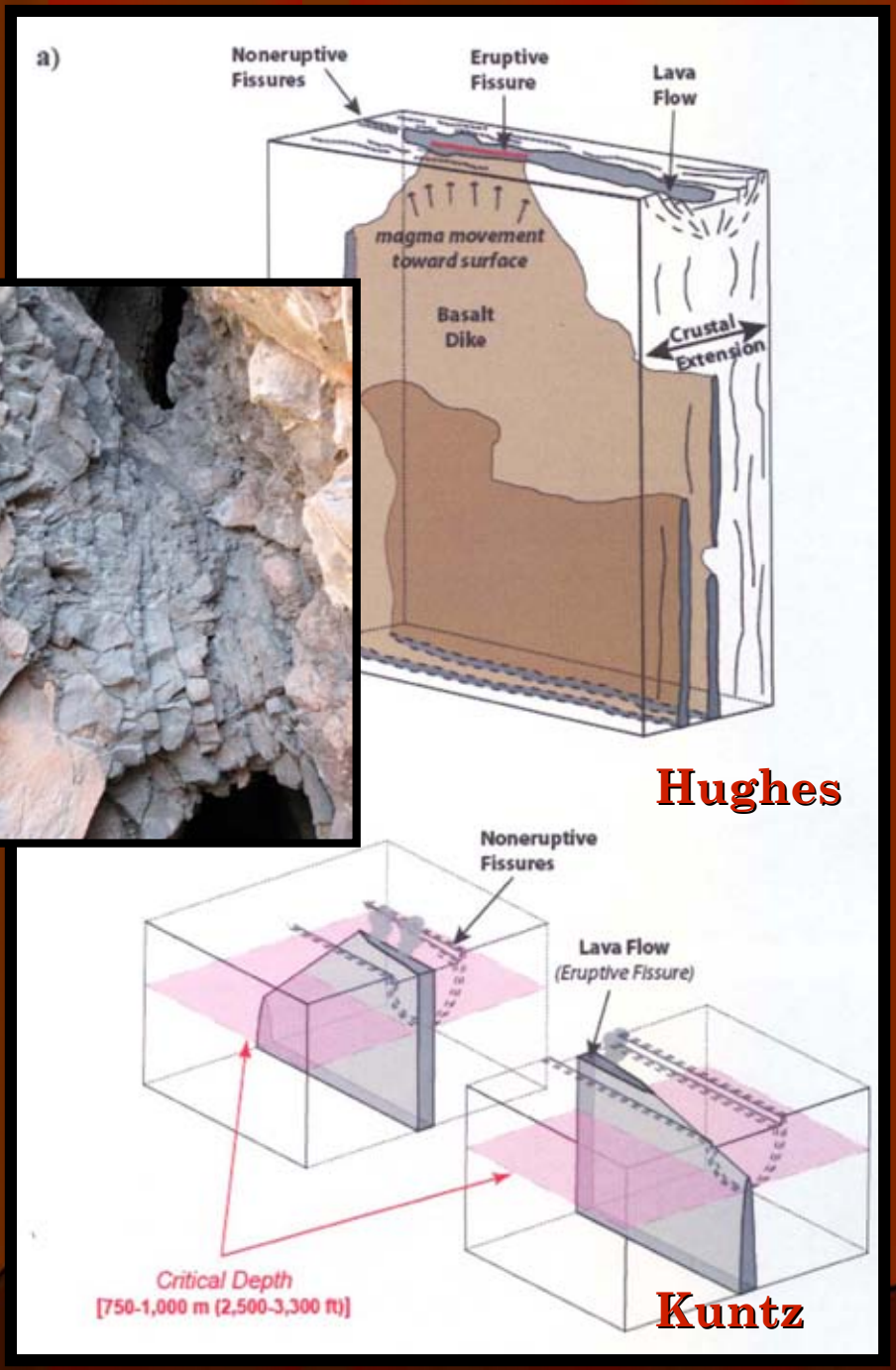


The activity at Mount Borah back in 1983 tells us that faulting caused by extension is alive and well in Idaho and could occur again at any time.

The magnitude 6.9 earthquake was originally listed as a 7.3

EarthScope is providing important data, for example in 2009 Seth Carpenter (INL) reported that between the INL seismic network and the EarthScope's US Array that since 2007 13 deep earthquakes had been recorded beneath the SRP:

"*The observed depths are significant as they are located near and around the base of the midcrustal sill where magma is thought to reside and at depths hypothesized to be source regions for dikes.*" The "*waveforms from the majority of theses earthquakes are quite similar to waveforms recorded from events categorized as hybrid and long-period volcanic earthquakes in other active volcanic regions.*"

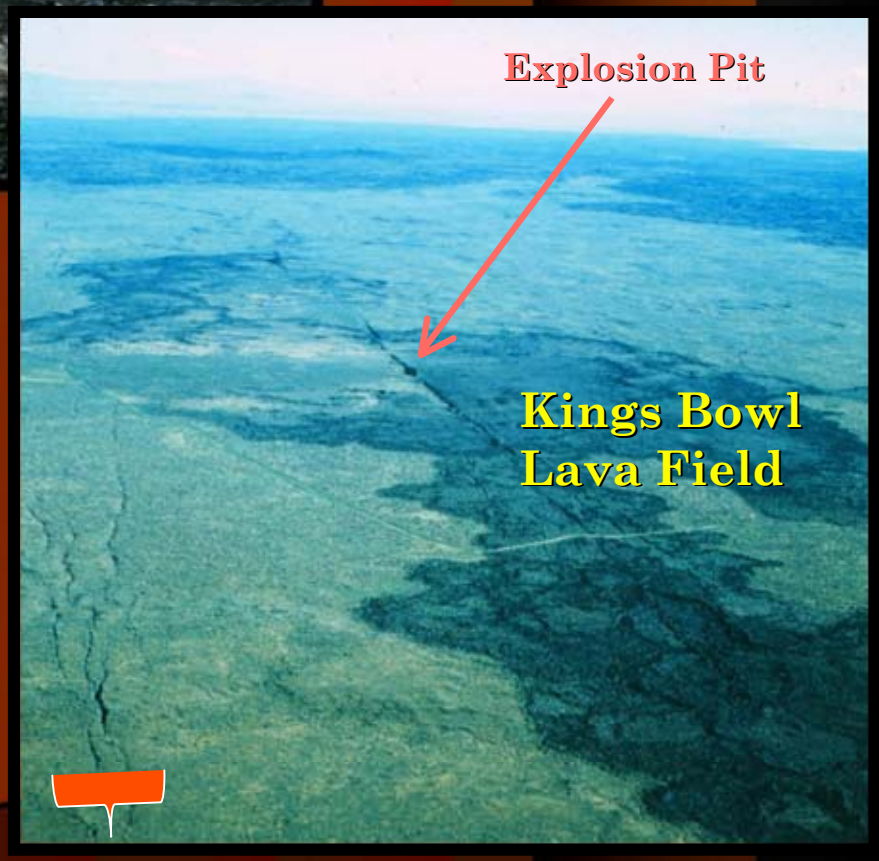


Stretching the crust can promote melting of the hot rocks left behind by the Yellowstone Hotspot and provide a pathway.

Magma, molten rock, rises until a point of neutral buoyancy is reached (like a submarine does depending on how much ballast water it has taken on.

There are often non-eruptive fissures that form on either side of the eruptive fissure in the zone where tension is produced by the rising blade or dike of magma.

Fissure Eruptions

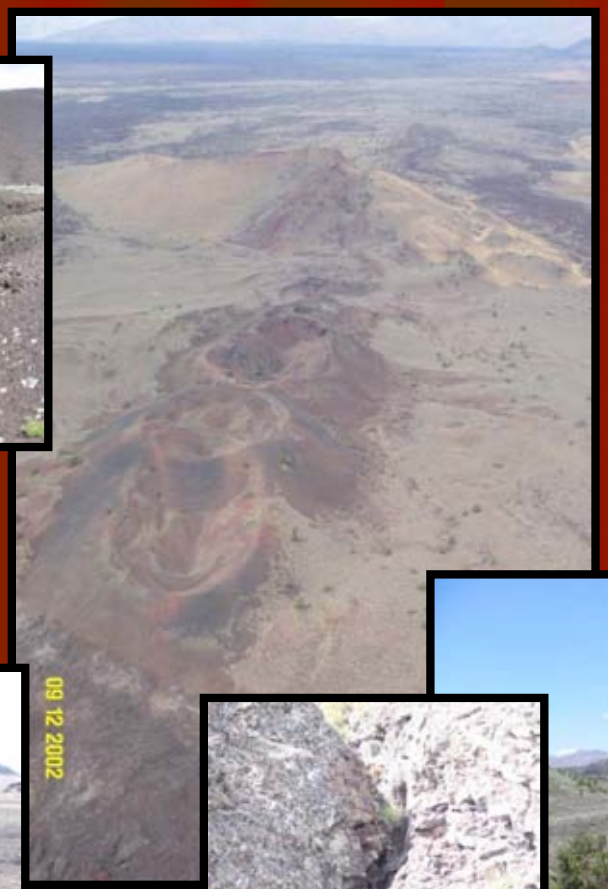


Non-Eruptive Fissures

Fountains of Fire

This fire fountain in Hawaii is 2,000 feet high.

Great Rift



Volcanoes

Laidlaw Butte is the largest volcano in the Monument.

900’ tall

Crescent Butte is the oldest volcano in the COM lava field ~15ka.

Big Cinder is the largest volcano in the COM lava field.

>700’ tall

Flank eruption on Watchman associated with the Trench Mortar Flat event.

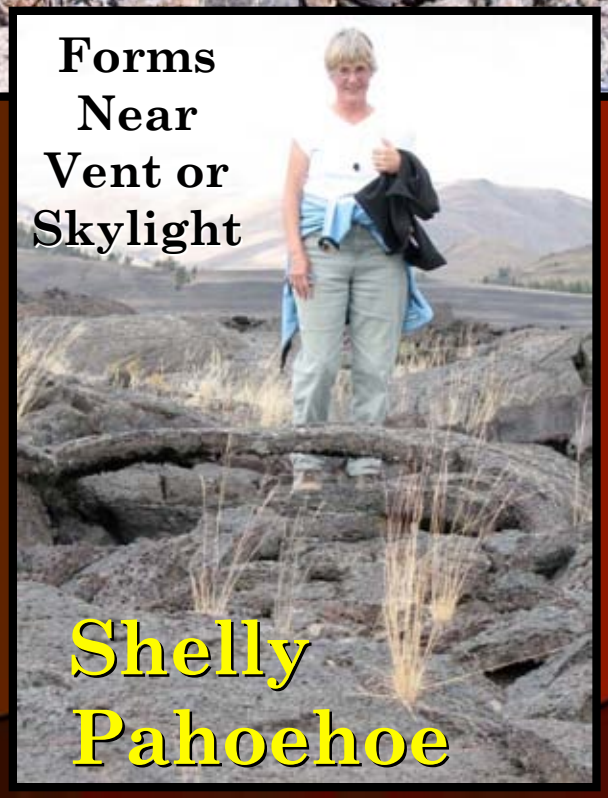
Spatter Cones/Ramparts & Hornitos

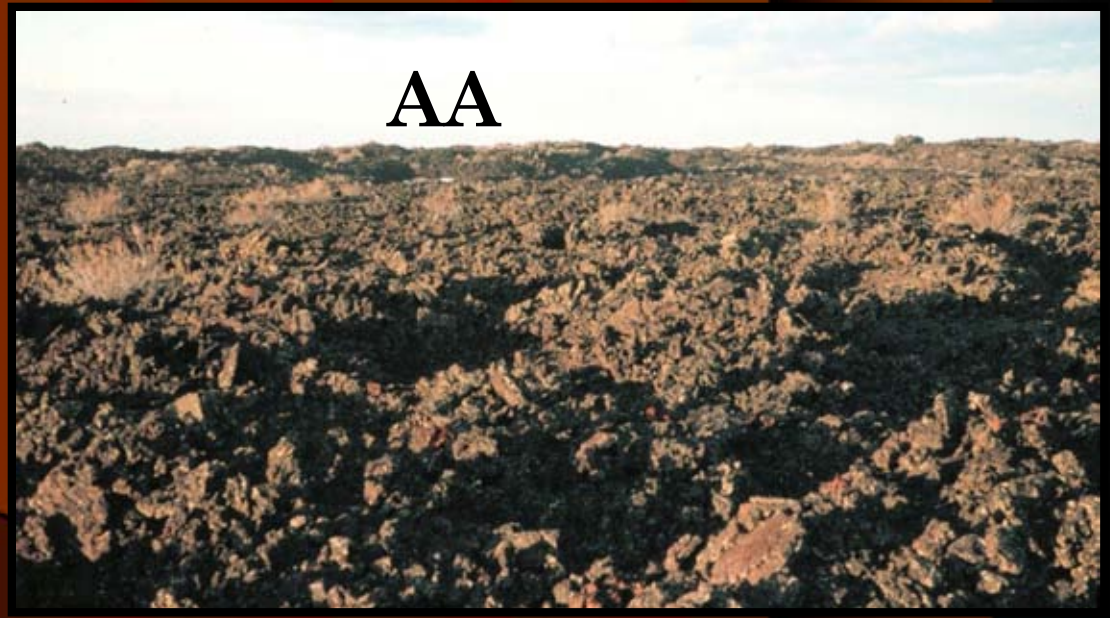
Spatter cones are fed directly by the eruptive fissure, hornitos are fed through a hole in a lava tube.

Lava


Pahoehoe


Block


Forms
Near
Vent or
Skylight
Shelly
Pahoehoe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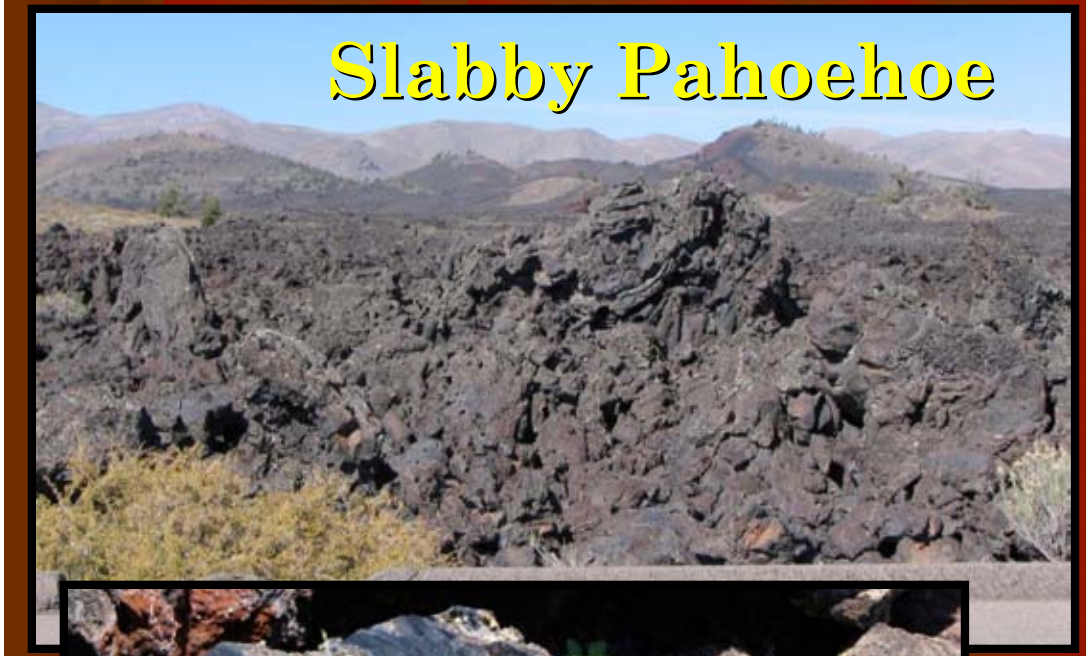
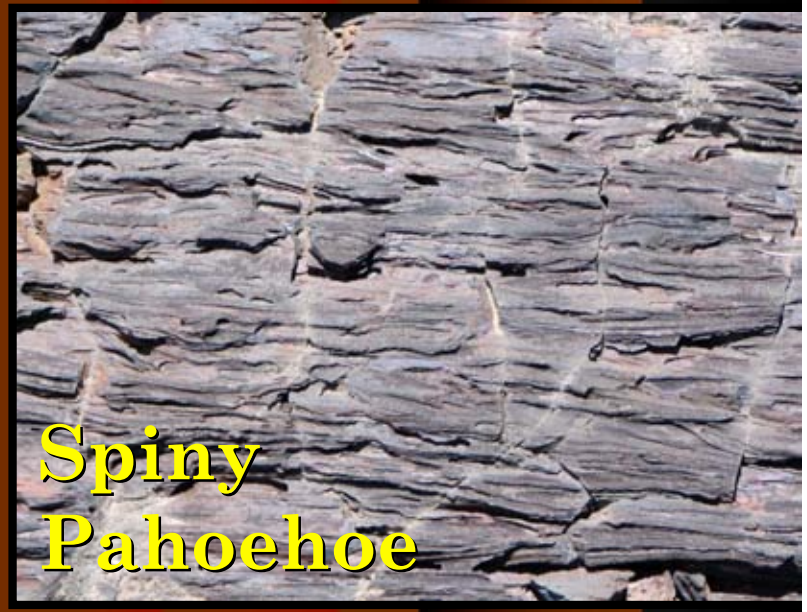
Lava Continued

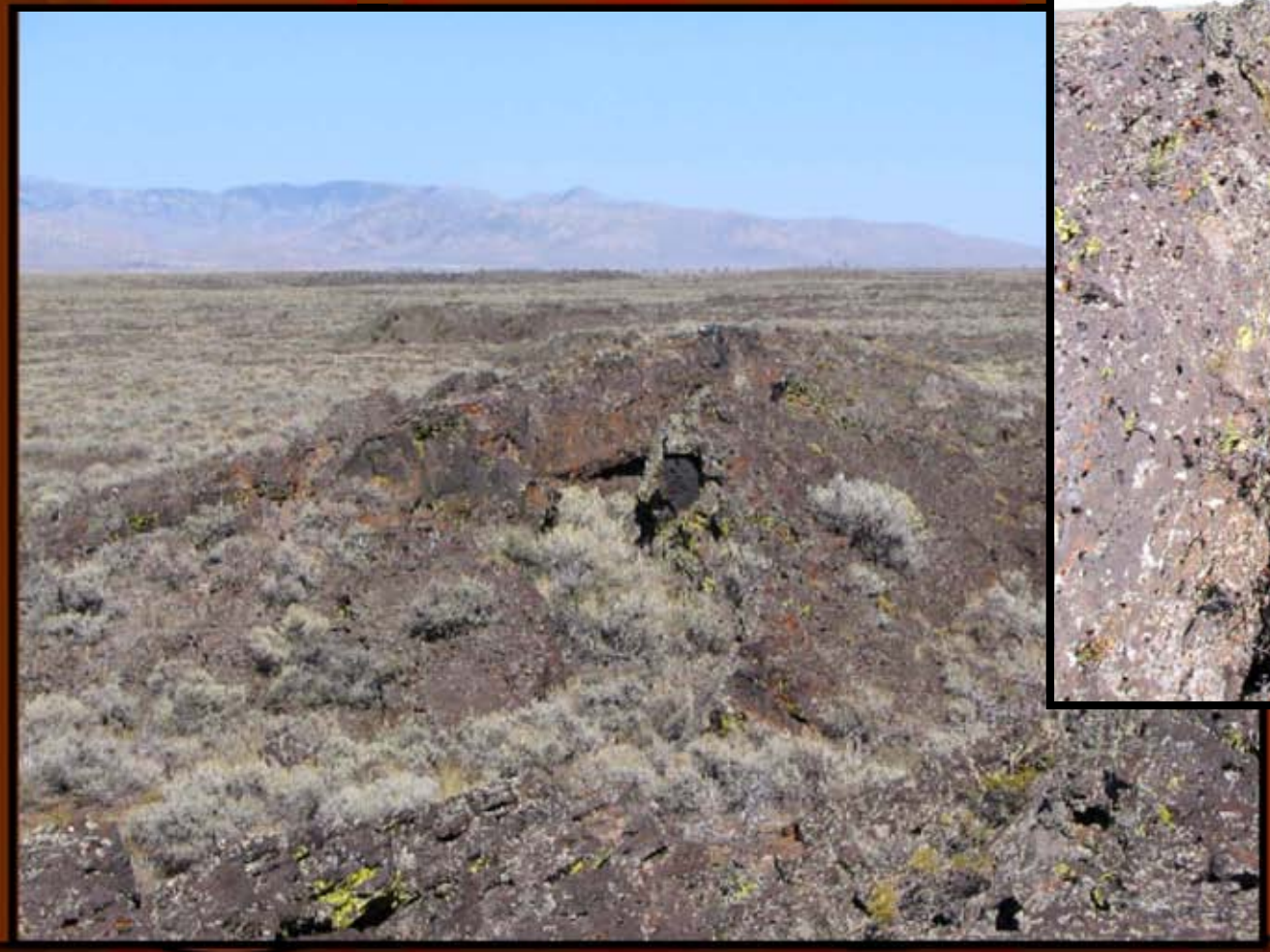


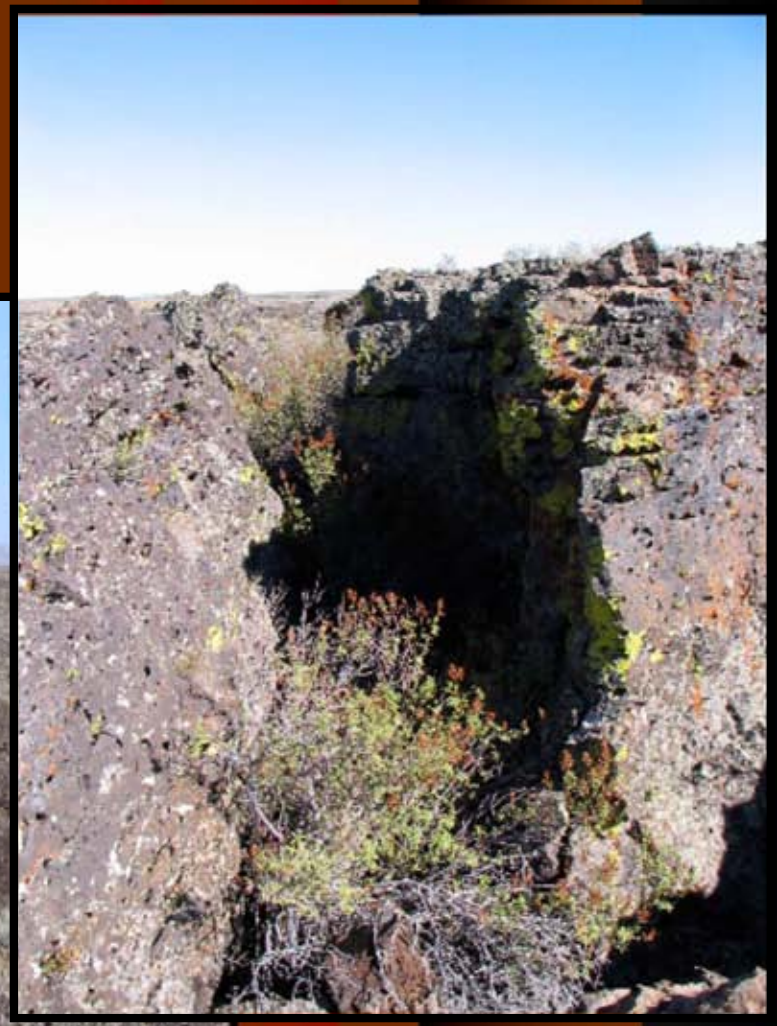


Lava Continued

Tumuli-

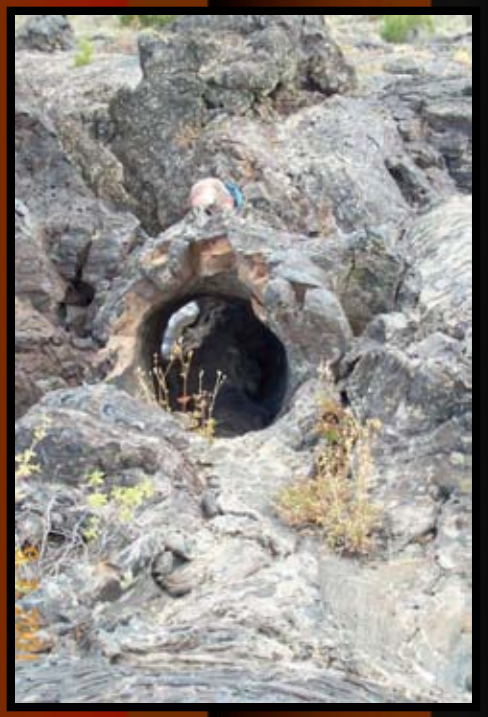
A doming or small mound on the crust of a lava flow, caused by pressure.





Craters has lots of hummocky flows.

Tree Molds

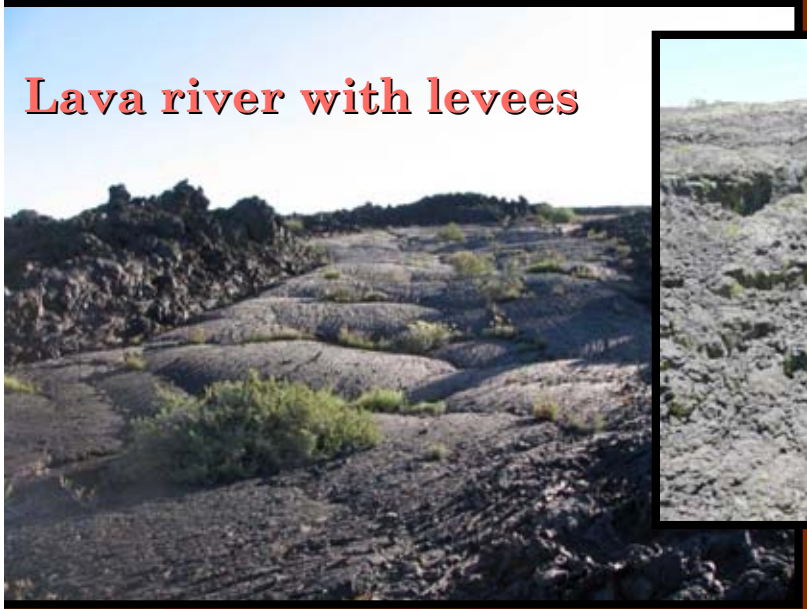


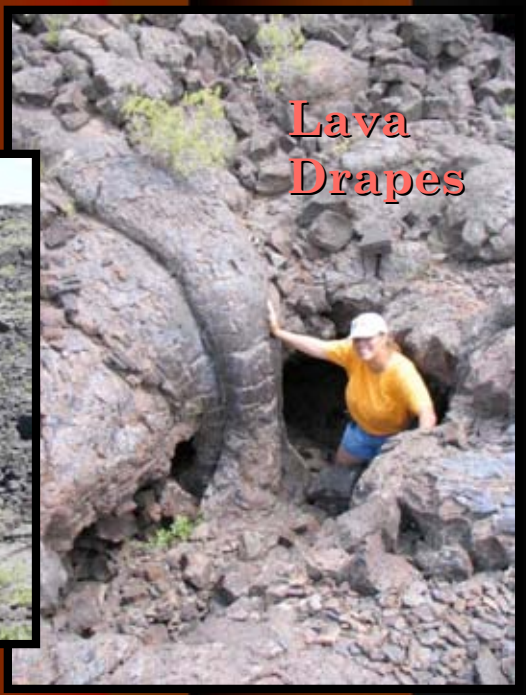
Bombs

Bombs Continued

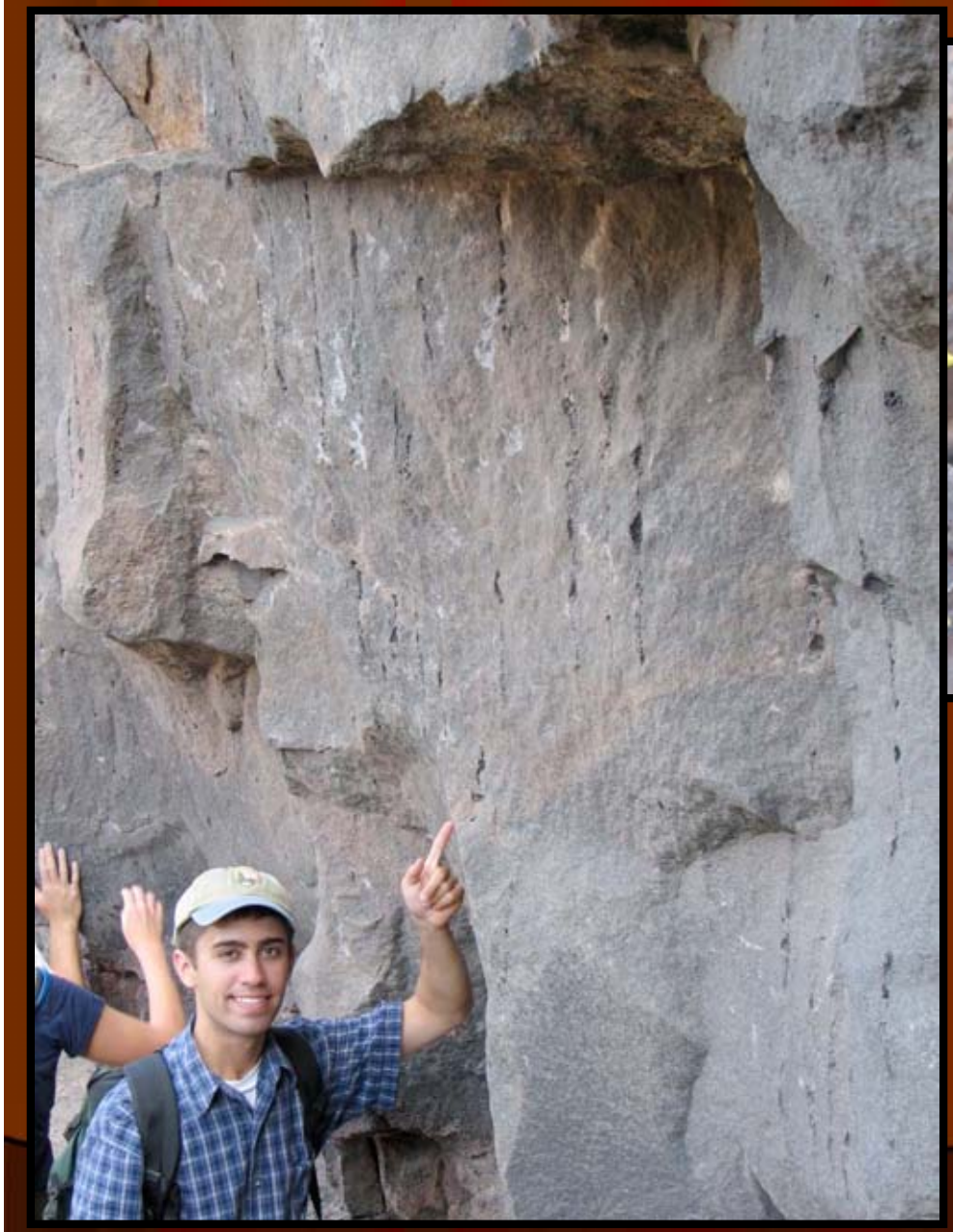
Cow-pie bombs

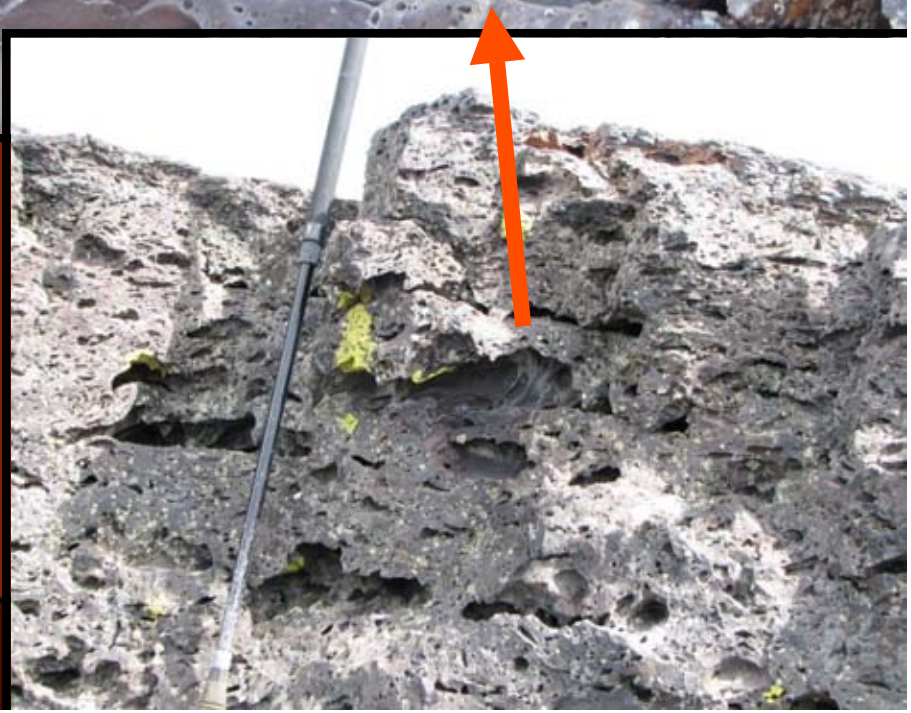
Lava Features





Lava Features Continued-Vesiculation

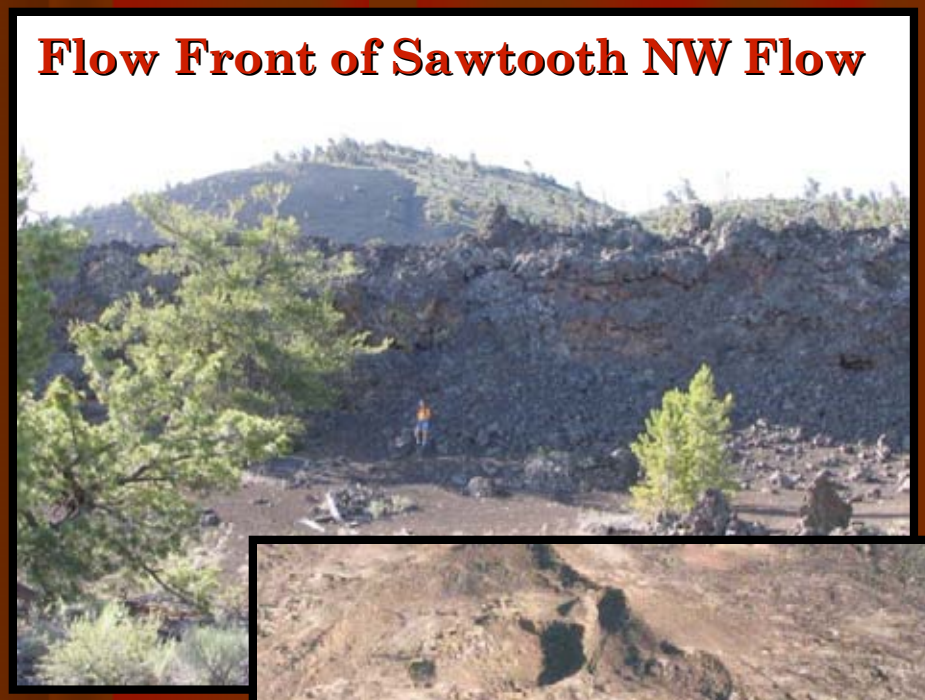


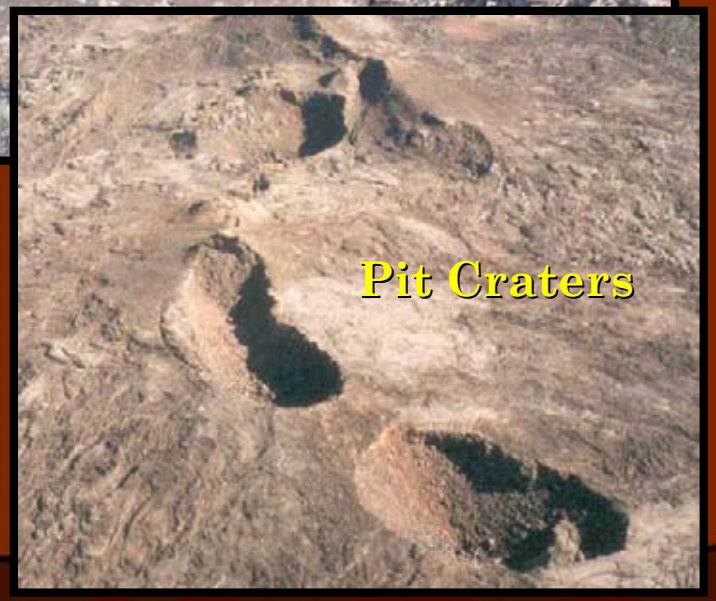


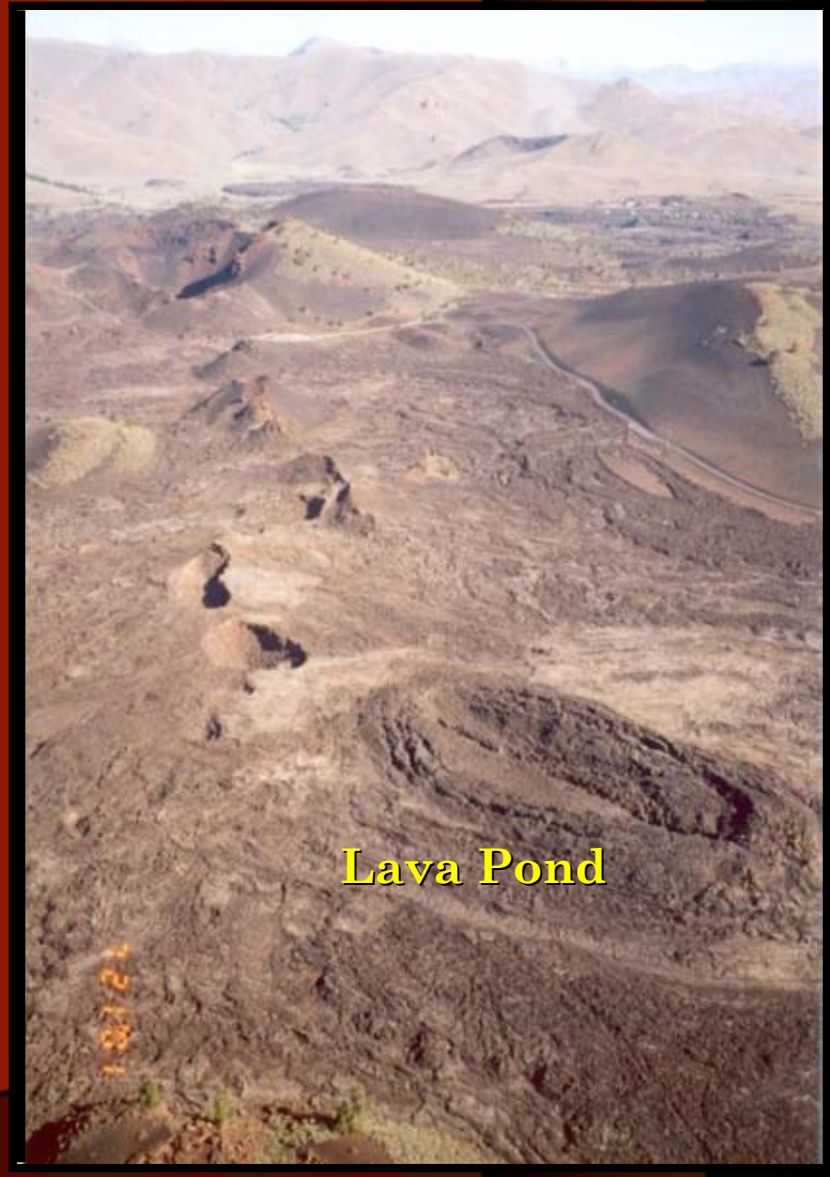
Lava Features Continued

Distributary Channels that carried lava away from the vents of the Wapi Lava field.

Lava Features Continued

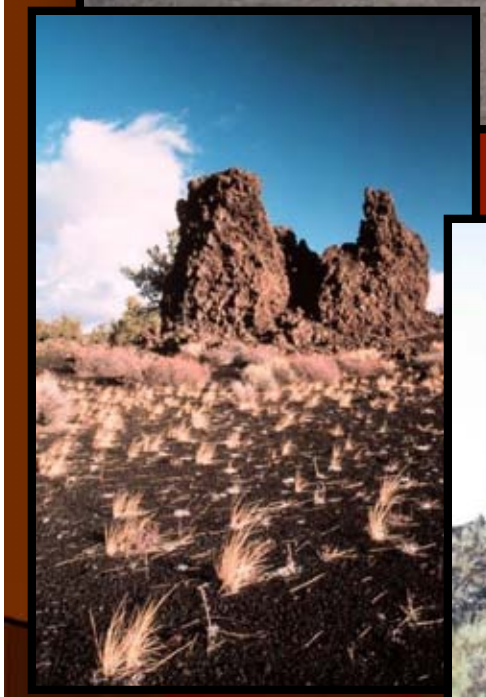






Lava Features Continued

Kipukas- older areas surrounded by younger flows



Rafted Blocks

Xenoliths

Xeno- foreign,
Lith- stone

Caves

Caves Continued

Exploration, research, and education have been going on here for over 100 years, and EarthScope can contribute!