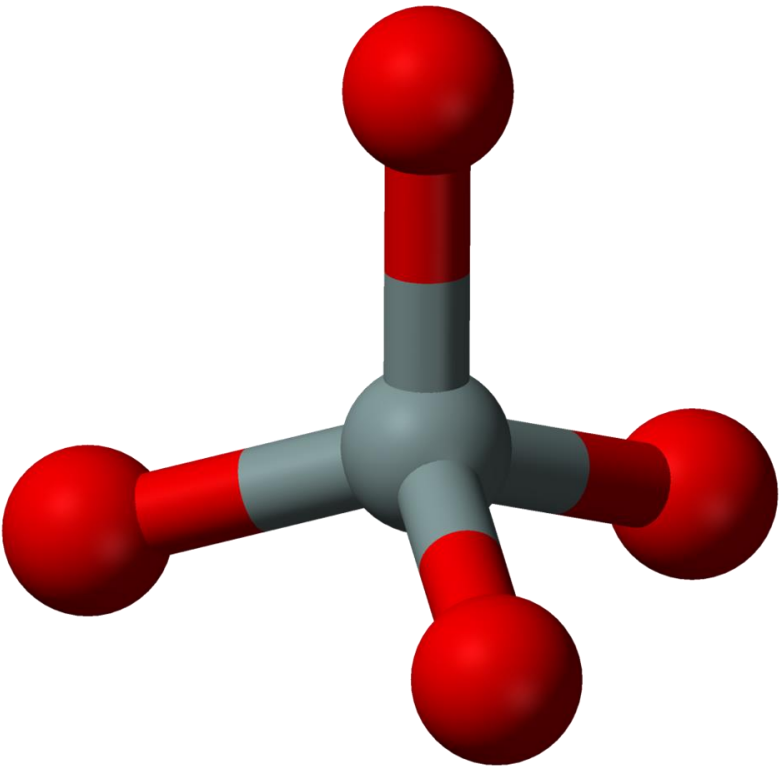
Mafic Volcanoes of New Mexico

Part I: The meaning of mafic, types of lava flows, and lava tubes

Not all volcanoes are the same because not all magma is the same.

The type of magma reaching the surface determines the characteristics of the lava flows and type of eruption.

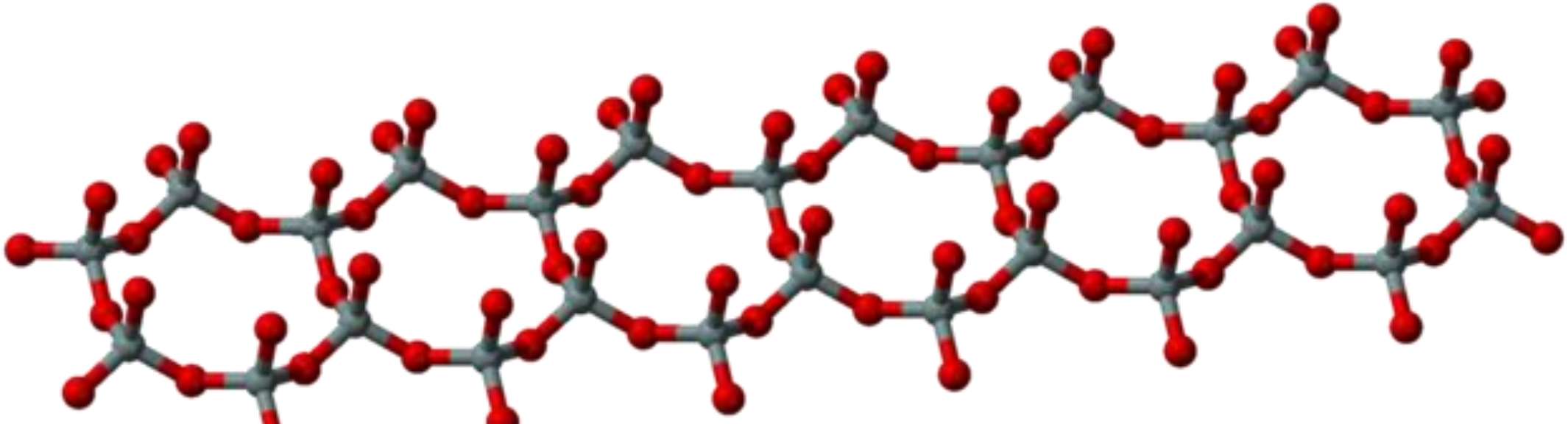
A major component in magma is a compound called ‘silica’



Silica is a silicon atom surrounded by oxygen atoms. They form a pyramid structure like this. This is known as a “silica tetrahedron.”

The amount of silica in magma can vary from ~45% to ~75%

The silica tetrahedra link together to form chains. This is known as polymerization. This is similar to when humans create polymers of carbon to form plastic. Silica is a natural polymer and all volcanic rocks contain some.



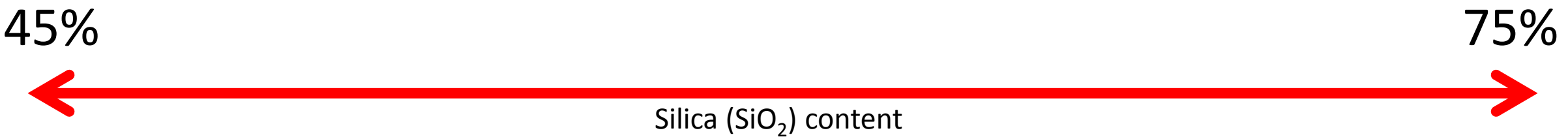
The amount of silica in magma determines the viscosity of the magma

The more silica in the magma, the more of these polymer chains exist. The more chains that exist, the higher **viscosity** of the magma. A magma with high viscosity does not flow easily. A magma will **low** amounts of silica have **less** chains and thus **lower** viscosity (will flow easier).

At the extremes, magmas can have viscosity so low that they can almost flow like hot honey or so high they are more viscous than pine pitch.

Volcanic rocks are classified according to their silica content

Because silica is so critical to the behavior of magma, geologists use the silica content as a basis for volcanic rock classification.



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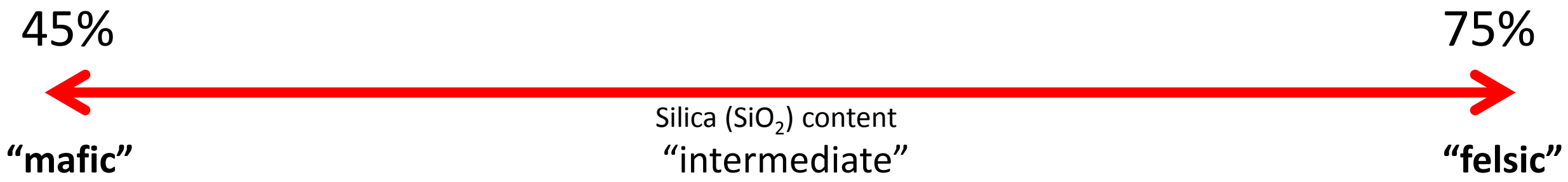
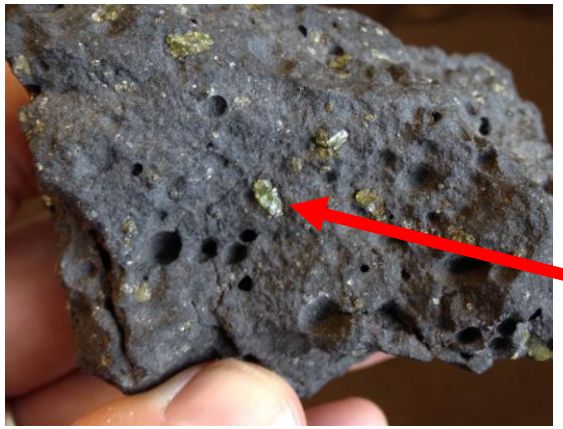


One way to classify volcanic rocks is to classify them into three groups based on silica content: **mafic**, intermediate, and **felsic**. Geologists actually have many categories and names for volcanic rocks based on silica content, but we are only going to stick with these three basic groups. In fact, I’m going to focus on the two ends of the spectrum – mafic and felsic.

Mafic volcanoes

When mafic magma reaches the surface, it will create volcanic rocks that have the following features:

- Dark black to grey in color (due to presence of iron and magnesium)
- Relatively heavy (dense) compared to other volcanic rocks
- May contain tiny greenish crystals of the mineral olivine
- May contain tiny rectangular crystals of the mineral plagioclase feldspar



Mafic volcanic rocks are usually given the name **basalt**.

Types of basalt flows

When mafic magma spills out onto the surface, it will create a lava flow. Because of the low viscosity of mafic magma, these lava flows can move at relatively fast rates (maybe as fast as you can walk)

There are two main types of mafic lava flows: **AA** and **Pahoehoe** – both are Hawaiian Words. Both are basalt but the textures are different.

[pictures on following slides]

Pahoehoe:

- Flows are usually relatively thin
- Smooth or ropy surface
- Proceeds in moving lobes

Image credit:
http://www.minersoc.org/images/photos/52b304fb52325.jpg

Pahoehoe

Image credit: https://volcanoes.usgs.gov/volcanoes/kilauea/archive/multimedia/2010/Aug/20101028_0172_kwooten_L.jpg

Pahoehoe

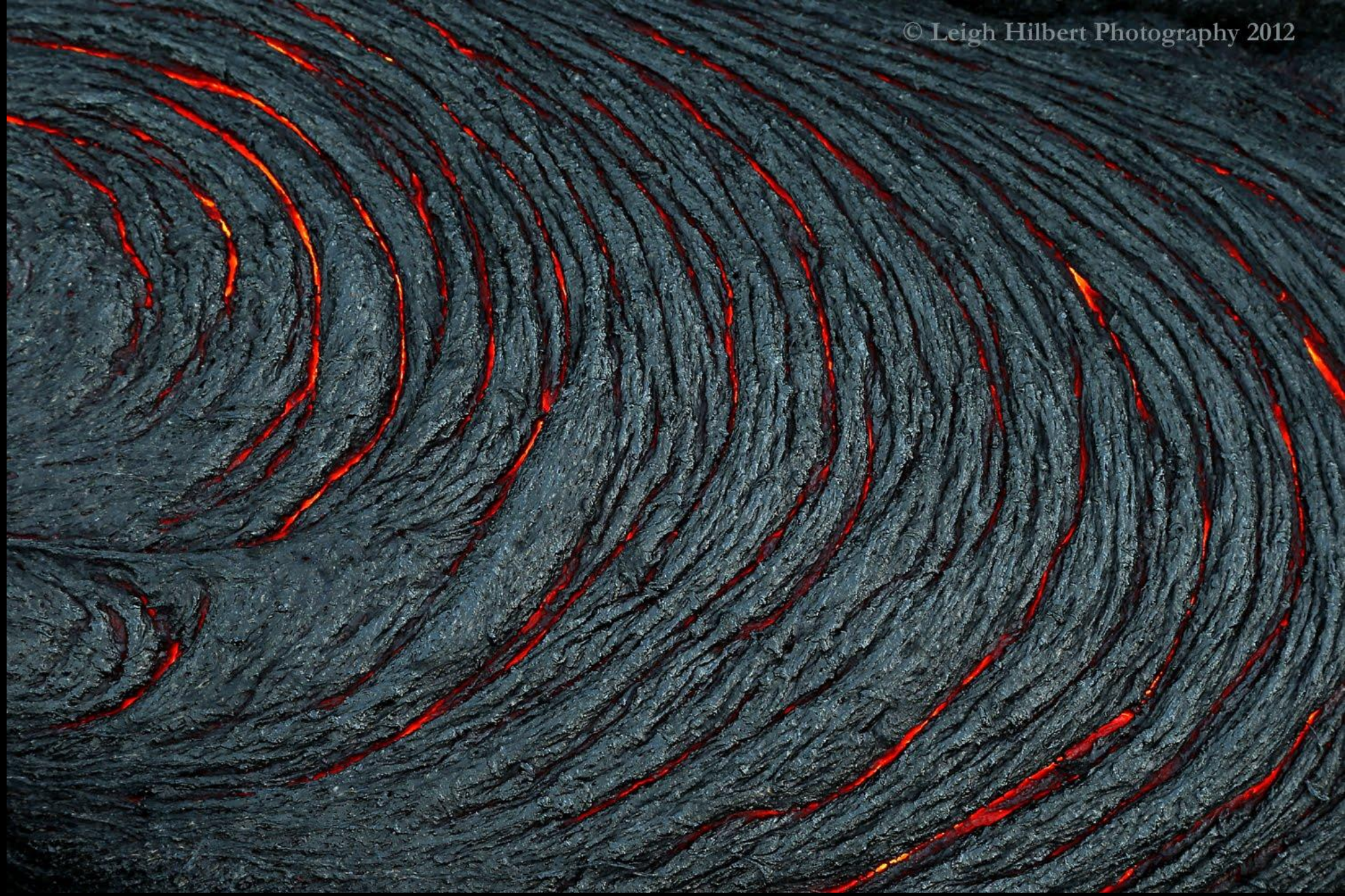


Image credit: http://2.bp.blogspot.com/-R5UuY8h6djU/UHoC6lWLWuI/AAAAAAAADUg/ZhRgoNh88ic/s1600/LHP_roping-3_0174_sml.jpg

Pahoehoe

Image credit:
http://blogs.agu.org/martianchronicles/files/2008/08/img_55021.jpg

Pahoehoe

Fresh pahoehoe appears metallic in some of these photos. This is due to the presence of naturally occurring glass, which is common in all volcanic rocks.

When magma reaches the surface, it finds itself in an extremely cold environment compared to where it came from. Ions in the magma try to get into the correct position to form crystals (minerals) but the magma cools and freezes before the ions can get into their correct location. [continued]

Image credit: http://geotripperimages.com/images/DSC05575%20Ropy%20pahoehoe.jpg

Pahoehoe

The resulting chaos of ions that are not in their proper position creates glass. Humans create glass by melting a silicate mixture and cooling it quickly. Lava is very similar though the resulting glass is not transparent.

Glass is unstable in nature. While fresh volcanic rocks are shiny, glassy, or metallic in appearance, over time the glass starts to absorb water and decays in a process called devitrification.

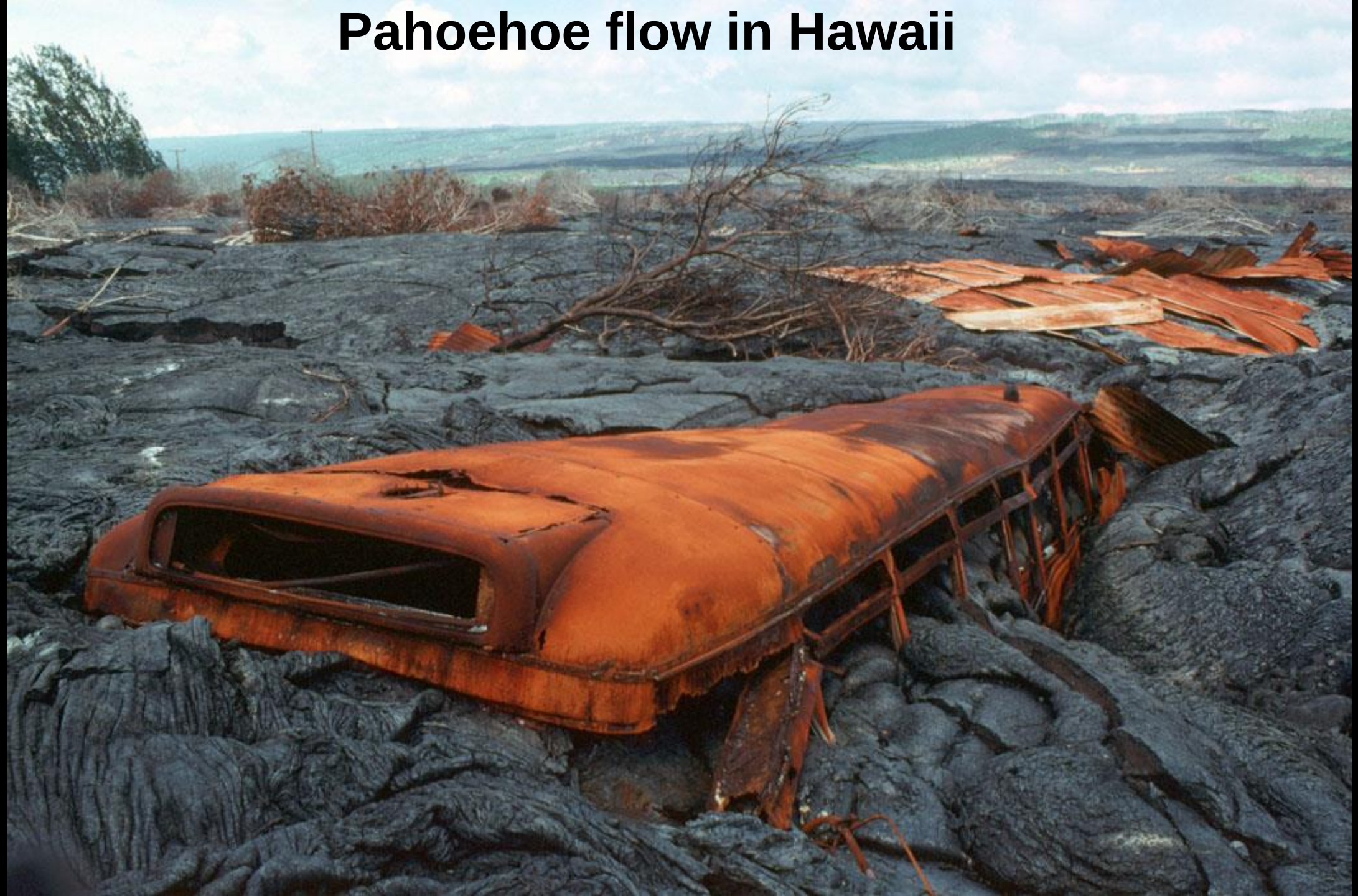
Image credit: https://hvo.wr.usgs.gov/multimedia/uploads/multimediaFile-558.jpg

Pahoehoe

In this photo, the pahoehoe on the right is newer than the pahoehoe on the left – probably by several years or decades. Notice the difference in luster between the two different flows.

Image credit: http://geotripperimages.com/images/DSC05558%20Fresh%20pahoehoe%20flow%20on%20Chain%20of%20Craters.jpg

Pahoehoe flow in Hawaii



AA flow:

- Blocky, rough texture
- Propagates forward slowly

Image credit: http://solarviews.com/raw/vss/VSS00104.jpg

AA

In this photo, AA overlies a slightly older pahoehoe flow. Notice the difference in textures between the two flows.

You might also notice that the AA has shades of red. Although basalt is black, the iron within it can rust to a red color, especially if there is water present during the eruption.

Image Credit: http://www.luckysci.com/wp-content/uploads/2014/08/Aa-Flow-vs-Pahoehoe.jpg

AA

New AA flow being emplaced over an older pahoehoe flow

Image Credit: http://www.hawaiimagazine.com/images/content/more_Kilauea_lava_flow_photos/Volcano4.jpg

AA

These guys are pacing ahead of the AA flow to calculate its speed. AA flows are usually very slow - usually their movement is barely perceptible.

Notice how tall this flow is. While the outer parts are solid (and black), the inner portion is still liquid.

Image Credit: http://www.hilo.hawaii.edu/~csav/gallery/decker/images/Aa_run.jpg

AA

Hawaii AA flow moving over an older pahoehoe flow

Image Credit: http://www.bigislandvideonews.com/wp-content/uploads/2016/06/2016-06-28-aa-flow.jpg

Rock is a great insulator. The top of the lava flow freezes solid, allowing the interior to stay molten and flow beneath the surface.

Here part of the surface has collapsed and we can see where the lava is still flowing underground.

Image Credit: https://volcanoes.usgs.gov/volcanoes/kilauea/archive/multimedia/2010/Aug/20100930_1270_torr_A_L.jpg

Illustration of how rock is an excellent insulator of heat. This person is standing only a few feet above molten lava.

Image Credit: http://hawaiitribune-herald.com/sites/hawaiitribune-herald.com/files/article/3315958.jpg

Even though the top of this pahoehoe is completely solid, channels of lava are still flowing directly below the surface.

Image Credit: http://assets.inhabitat.com/wp-content/blogs.dir/1/files/2016/06/Kilauea-Volcano-Lava-Skylight-Aerial.jpg

A chunk of the roof occasionally falls into the lava below, forming a “skylight.”

Image Credit: http://assets.inhabitat.com/wp-content/blogs.dir/1/files/2016/06/Kilauea-Volcano-Lava-Skylight.jpg

This skylight shows lava flowing a couple of feet below the surface.

Image Credit: https://volcanoes.usgs.gov/volcanoes/kilauea/archive/multimedia/2010/Aug/20100930_1270_torr_A_L.jpg

Image Credit: https://img.huffingtonpost.com/asset/5769dbb41500002f001baaf9.png?ops=1910_1000

Eventually the eruption will cease and the lava will stop flowing. Most of the lava will drain from these underground channels, leaving behind a network of empty tubes.

In this photo you can see that the lava has subsided and is now a small stream at the bottom of this cavern. After the eruption is over, this cavern will eventually cool off and leave behind a tunnel.

Image Credit: http://www.hilo.hawaii.edu/~csav/gallery/scientists/LorenL.jpg

Many years after the eruption is over, these channels are known as “lava tubes”

On the left you can see a horizontal line that shows where the lava level was for a while before draining – kind of like a ring in a bathtub.

Image Credit: Mel Strong

The size of lava tubes can vary from so small you would have to crawl on your stomach to large cavernous tunnels. This is one of the largest lava tubes in existence.

(Skull Ice Cave in Lava Bed National Monument)

Image Credit: Mel Strong

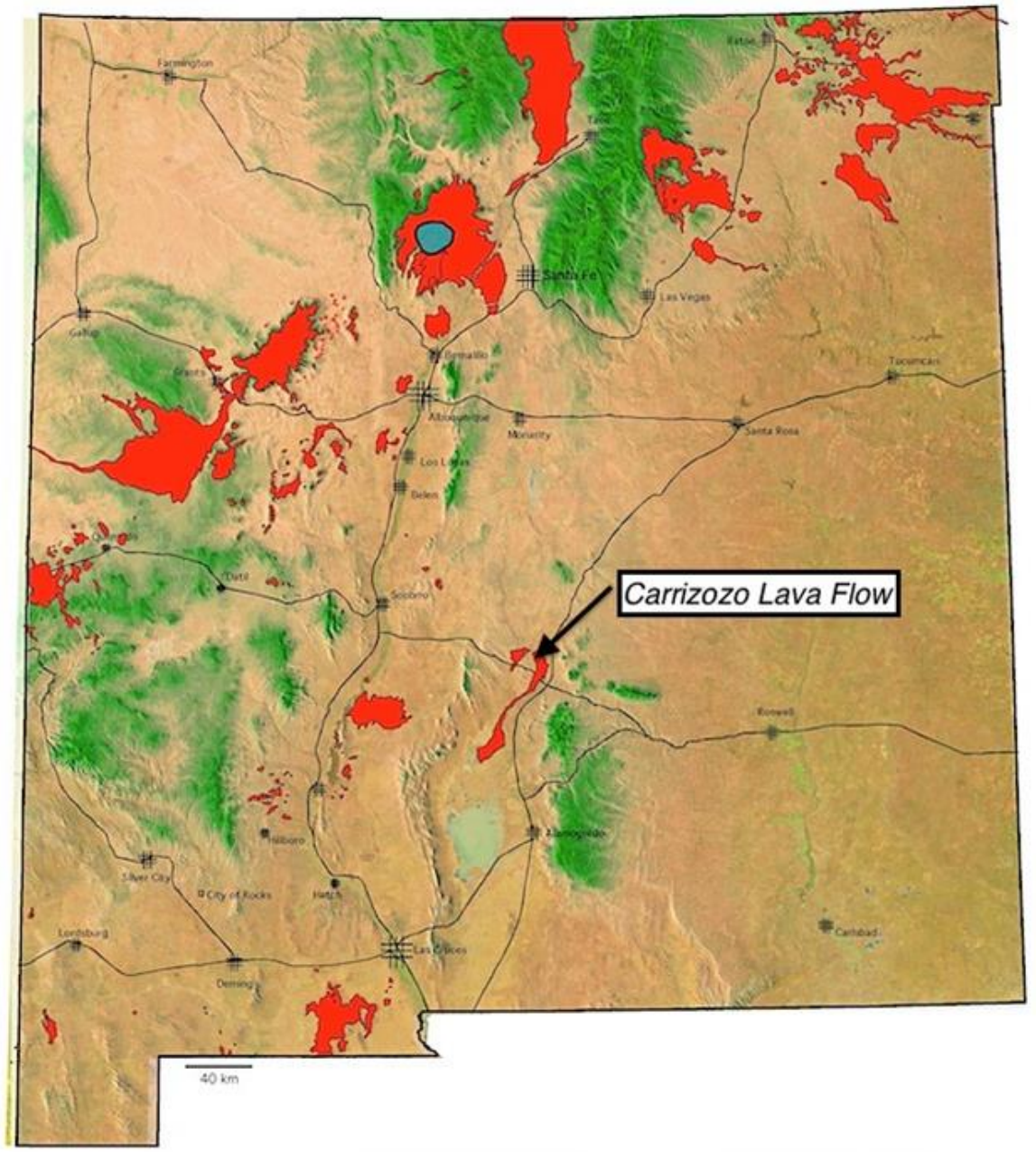
Mafic Volcanic Features in New Mexico:

New Mexico has examples of all of the features just shown:

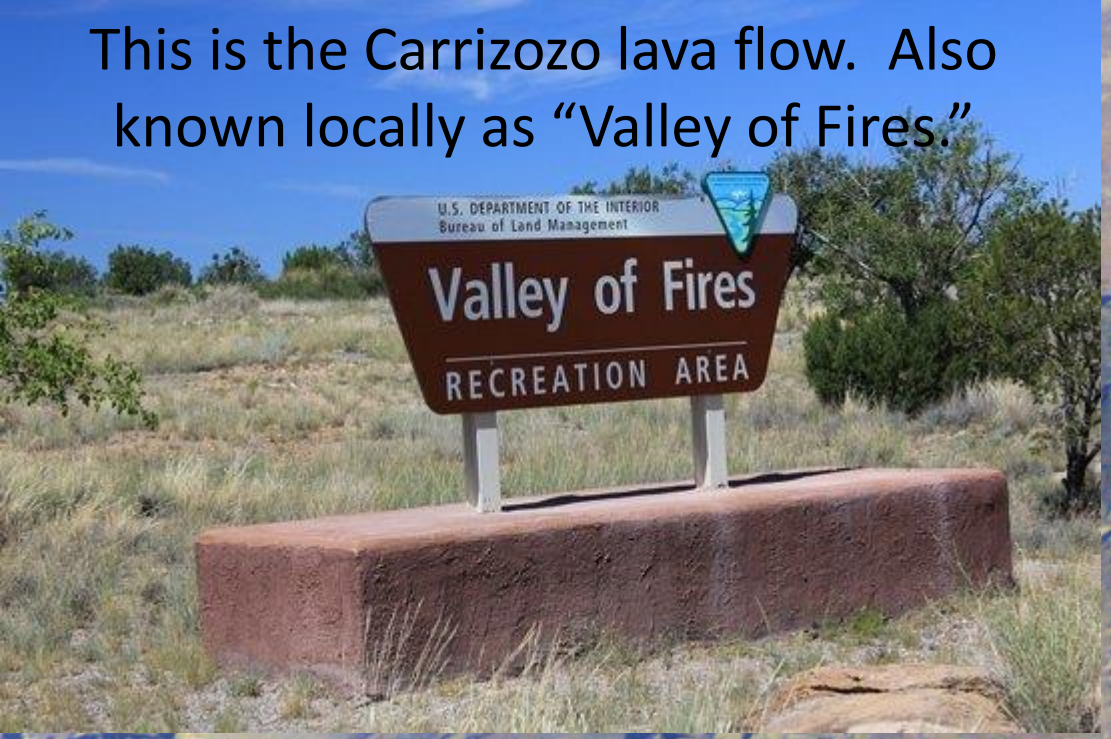
AA Lava Flows
Pahoehoe Lava Flows
Lava Tubes

There are many places in New Mexico to find mafic lava flows. There are several that are fairly young. The map to the right shows all volcanic rocks that are less than 5 million years old (red zones). Not all of these are mafic, but many of them are.

First let's look at the Carrizozo flow.



This is the Carrizozo lava flow. Also known locally as “Valley of Fires.”



Carrizozo Lava Flow


Carrizozo
Nogal
Alto
You can easily find it on Google Earth as this elongate black feature
© 2017 Google
Image Landsat / Copernicus
Google Earth


The lava flow is not far
from White Sands

This is the Carrizozo flow. There is a paved path that extends out into a portion of the flow near the park entrance. This makes it easy to go out onto the flow and look for lava features.

Image credit: https://s-media-cache-ak0.pinimg.com/originals/35/f6/2f/35f62f05d5e7a5d33d2352e1b3947c87.jpg

Some classic ropy pahoehoe.

Image Credit: https://roadsendnaturalist.files.wordpress.com/2013/12/valley-of-fires.jpg

Notice that the overall terrain is not smooth. This lava flow is covered in 'hummocky terrain.' This is due to a process called inflation. When the surface of the lava cooled, lava below the surface continue to push in different directions, often causing the crust to expand upwards in places. After the eruption the lava drained from much of these locations similar to how lava tubes form. Many of this small black hills you see are hollow inside.

Image credit: https://cdn-assets.alltrails.com/uploads/photo/image/11467094/extra_large_16afe2cb19aad2855858e46275d79984.jpg

Out in the middle of the flow

Image credit: http://2.bp.blogspot.com/-WcKbPMZGAD0/UjcMFiDdiJI/AAAAAAAAMNA/vvapVBKhS2M/s1600/Valley+of+Fires+3.JPG

Another recently active basalt flow is the “McCartys Flow” which makes up the majority of El Malpais national monument. This is a mafic flow in western New Mexico.

This basalt flow is particularly picturesque as it laps up against sandstone cliffs.

All of the black that you see in the distance is the basalt.

Image credit: http://ncribble.com/Images/2016/El%20Malpais/ElMalpais.ElMoro-20.jpg.

Image Credit: https://upload.wikimedia.org/wikipedia/commons/thumb/0/06/ElMalpaisLava.JPG/1200px-ElMalpaisLava.JPG

In this image you can see some pahoehoe as well as inflation features. Notice how the surface has deep cracks. You have to imagine that during the eruption this was initially flat as the lava initially cooled, but then as more lava was injected below, the surface expanded like rising bread.

Image Credit: http://2.bp.blogspot.com/-5OmYrLG_NL4/VYiULUj7uvI/AAAAAAAAdU/YC5pXkUcq_U/s1600/ElMalpais3.jpg

Pahoehoe

Image credit: https://travelswithgrummy.files.wordpress.com/2013/05/lava.jpg

The McCartys flow as seen on Google Earth.

The famous Taos Gorge. The Rio Grande has eroded down through several lava flows. In this image you can see the stacks of horizontal black layers of basalt.

Image Credit: http://rob.com/bream/pix/var/albums/The-West-11/Taos-%26-Rio-Grande-Gorge/SDC13767.JPG?m=1318614623

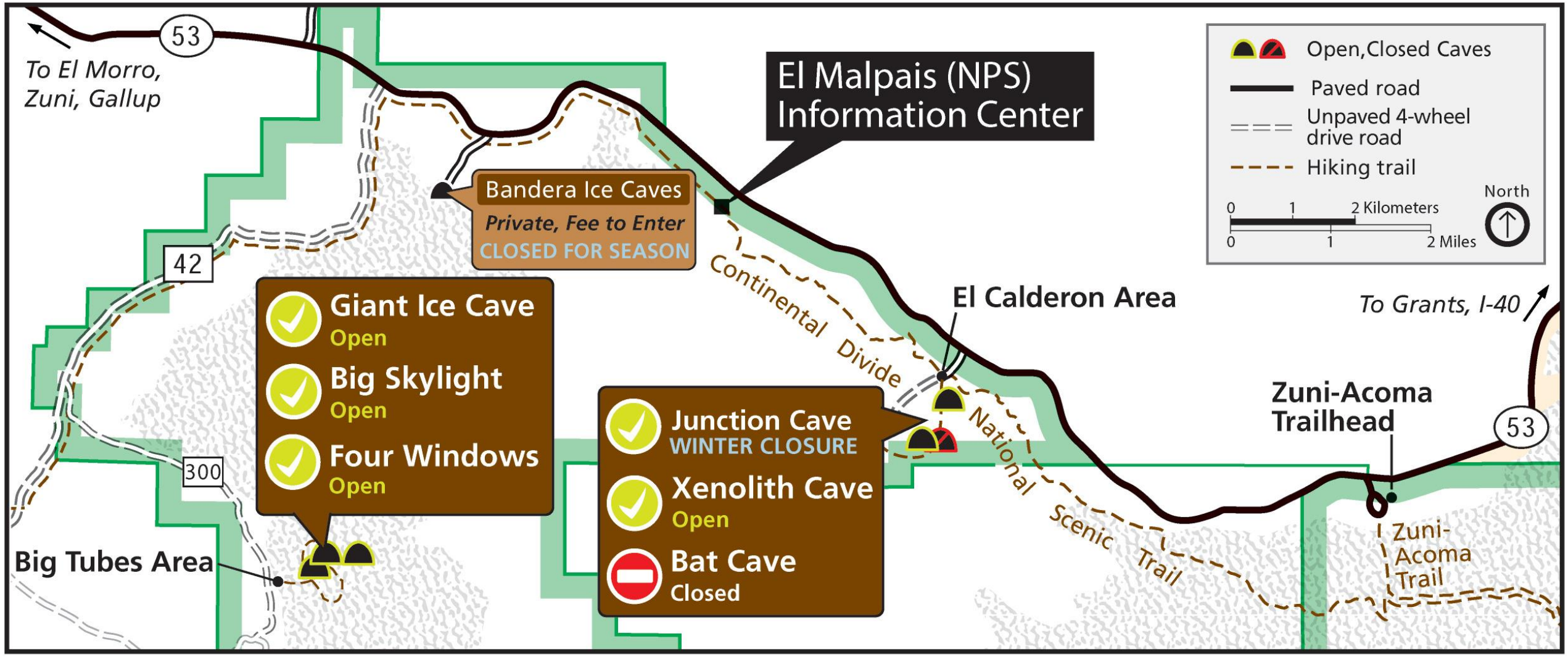
The famous Taos Gorge. The Rio Grande has eroded down through several lava flows. In this image you can see the stacks of horizontal black layers of basalt.

Image Credit: https://upload.wikimedia.org/wikipedia/commons/thumb/c/cd/Rio_Grande_Gorge_Bridge.jpg/1200px-Rio_Grande_Gorge_Bridge.jpg

If you live near Albuquerque, we have mafic lava flows right here. The rocks at Petroglyph National Monument are all basalt, part of a lava flow that extends for miles.

Image Credit: https://upload.wikimedia.org/wikipedia/commons/2/23/Petroglyph_National_Monument_008_by_Samat_Jain.jpg

The Petroglyphs are within a small portion of lava flows that are west of Albuquerque. In Google Earth you can see the edge of the mesa here – all made of basalt flows. In the past, the Rio Grande has eroded away at it, giving the shape you see here.



There are several lava tubes in New Mexico that can be explored. This map shows the caves open in El Malpais.

Image Credit: https://www.nps.gov/elma/learn/nature/images/v3-Cave-Brochure-Locations-Map-SummerWeb.jpg

Lava tube in El Malpais

Image Credit: https://i.ytimg.com/vi/h123zwDb4qE/maxresdefault.jpg

Occasionally lava tubes will contain ice. This happens if the cave is airtight except for a single opening to the surface. During the winter, freezing air fills the cave. The insulating properties of the rock and the density of the cold air are able to freezing temperatures in the bottom year-round.

Image Credit: https://static1.squarespace.com/static/59260555b3db2b0d0d6ba63f/59260645c534a59e69818588/593450bcdb29d6e182d7555a/1496682290535/icecave_1.jpg?format=1500w

Ice with some green algae – Bandera Ice Cave

Image Credit: http://kaitlyn.eduweb20.com/files/2014/05/IMG_3778.jpg

Bandera Ice Cave

Image Credit: https://i.ytimg.com/vi/bTgJTUdnIco/maxresdefault.jpg