Pinacate in stereo by Dan Lynch

Pinacate looks different in three dimensions. Some things are impossible to illustrate with a single, flat photograph; the third dimension is essential. Here I am, trying to tell a Pinacate story on your very flat computer monitor without Virtual Reality's expense and complication. Anyone can learn to see stereo without a Holmes Stereopticon (or equivalent), it just takes a little effort. You will be astounded by the return.

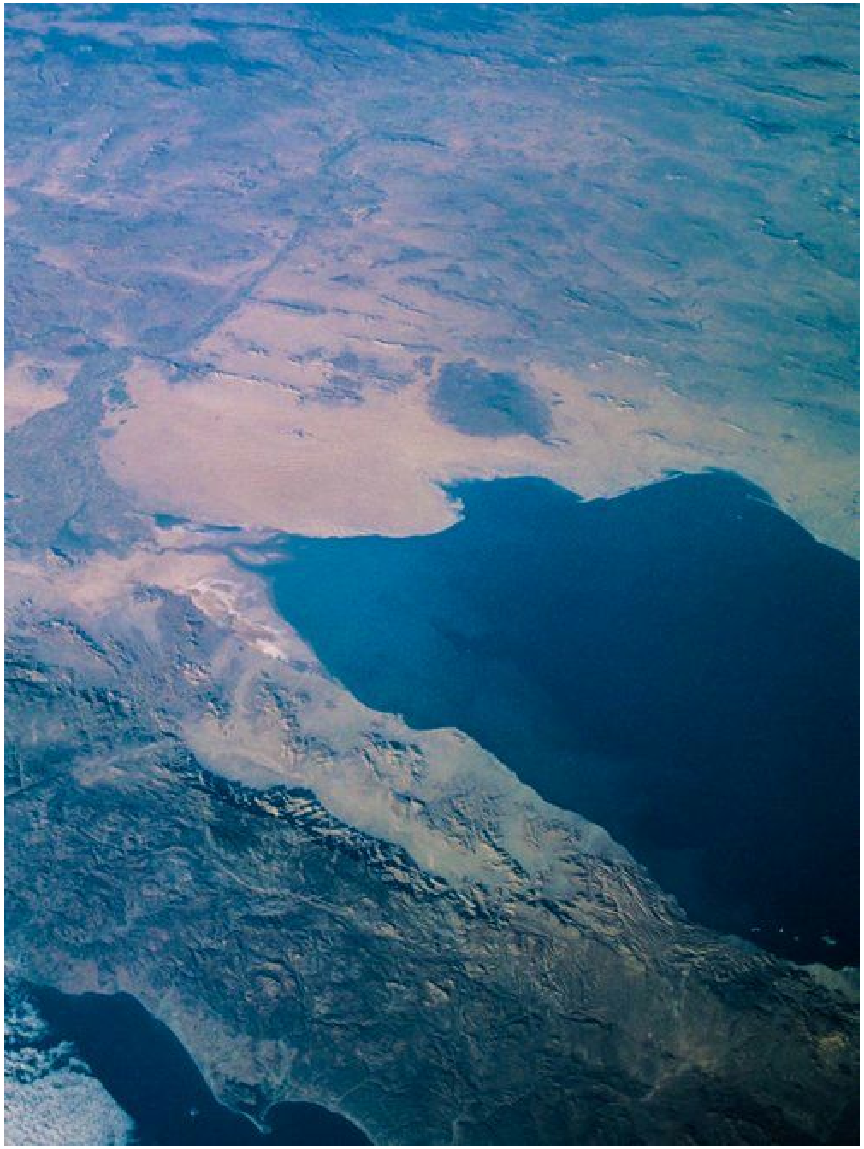
Stereo was once exclusive to geology; we mapped contacts in 3-d using pairs of aerial photographs. Today, organic chemists commonly publish stereo views of molecules in their journal articles. If chemists can learn to see 3-d, you can too.

Stereo viewing on your computer is essential. It’s strange if you’ve never done it but not difficult.

We have two ways to look at separate images; wall-eye and cross-eye. The trick for both ways is to always keep that black line at the top as a single line seen with both eyes - tilt your head if it’s split. All my stereo sets are triplets, the inside “left” image shared with the outside “right” images. The right-hand pair is the wall-eye stereo familiar to geologists. Stare into the distance; let the two white dots on the top black line converge in the blur and when they do, your eyes will naturally focus on the screen seeing the sharp view. You may have to do this a bunch of times to make it feel natural. Back away from your monitor or drag your window smaller if you are having trouble. This only works if the image centers are physically closer together than your eyeballs.

Cross-eye stereo is better because our eyes are designed to converge (so we can see up close). Hold your finger about a foot from your nose just under the white dots in the top black line. Tilt your head so that looks to be ONE black line then drop your finger to see the five volcanoes. If it doesn’t work right away, quit and come back to it. The advantage of cross-eye is being able to see stereo in much larger images with greater detail.

Pinacate, Mar de Cortes, Baja California, and the Southern Basin & Range



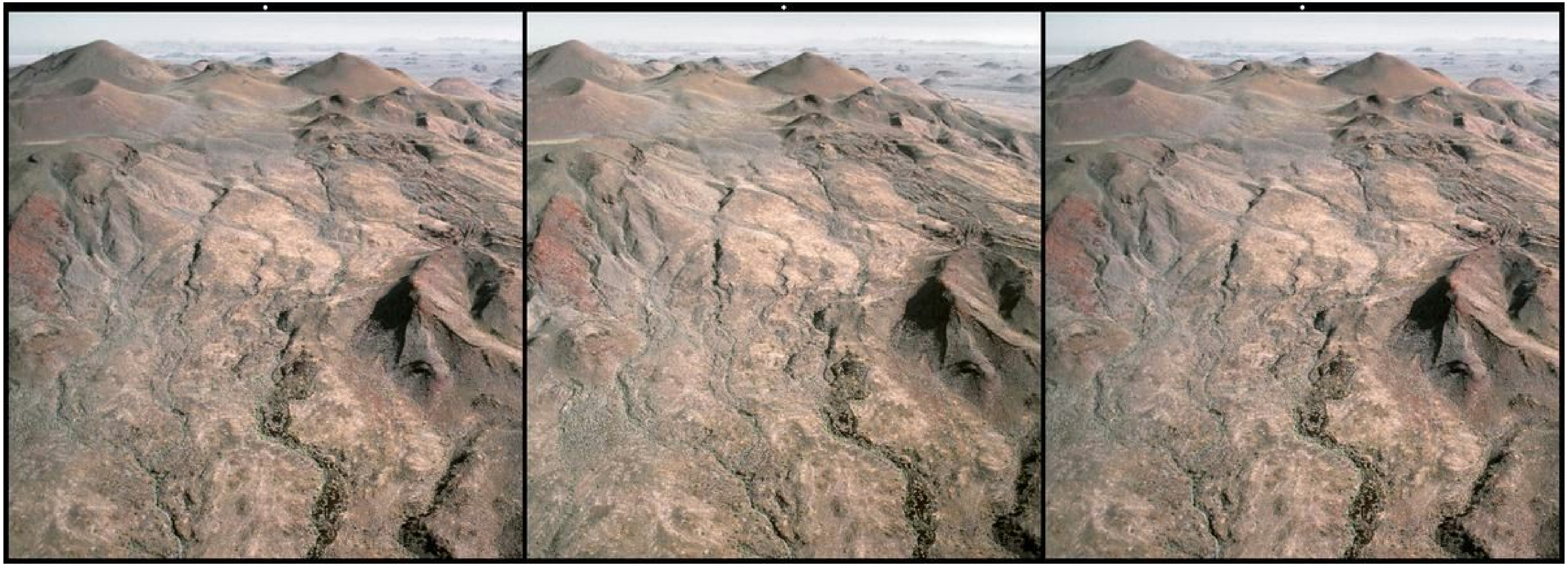
The black basalt of Pinacate stands out in contrast with the reddish tan sand of the Gran Desierto de Altar at the head of the Gulf of California. This sand from the Colorado Plateau was carried down by the newly organized Colorado River after the Gulf began to open six-odd million years ago. The sands and the waters hide a complex plate boundary but the Pinacate volcanism is not related to it.

This superb late afternoon image accentuates the parallelism of the “basin-ranges” northwest (to the left of) Pinacate in Arizona.

Here is a link to a Google Earth kml file that shows the named features in Pinacate. This file downloads to your computer and launches Google Earth. If you don’t have Google Earth, Pro is now free.

Volcan Santa Clara and its alkaline rock series

Volcan Santa Clara, the trachyte shield volcano under Pinacate, is composed of alkaline rocks ranging in composition from basalt to trachyte created by fractional crystallization of an alkali basalt parent magma. The light gray rock in the triplet is the Santa Clara trachyte on the east flank. Pinacate basalts erupted into topography developed in this rock on the top of the mountain.



Pinacate’s Great Maar Calderas

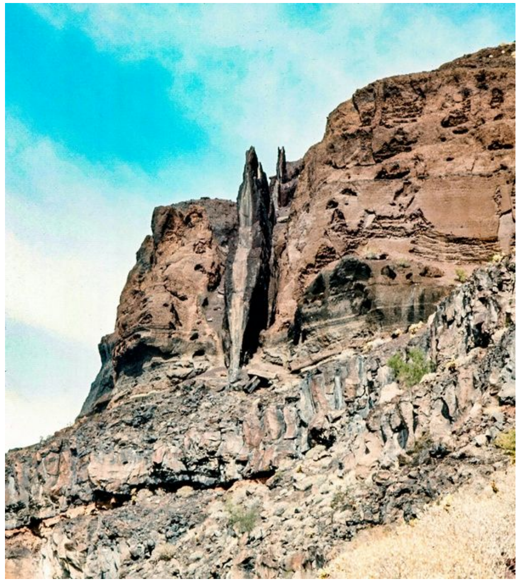
Elegante maar caldera was both blasted by steam explosions and collapsed by gravity through a stack of basalt flows that were lying atop valley-fill alluvium of the Southern Basin & Range Province. Hydrovolcanism is a feature of monogenetic volcanic fields. Pinacate has three giant, and a half-dozen smaller, maar calderas. They are its most famous features.

Most of Pinacate’s magmas came through the groundwater under the field without incident. In rare circumstances, not yet understood, some magmas exchanged heat with the water, quenching to palagonite as the water was flashed to steam. Palagonite, sediment, and blocks of disrupted basalt were blasted out of the eruption sites to form rings of “tuff breccia” around the volcanoes. Post eruption collapse finished the maar calderas. Elegante’s void space is half a cubic kilometer.

Layers of tuff breccia are found between layers of basalt scoria in several ordinary volcanoes. Hydrovolcanism is one of Pinacate’s mysteries.

Another view of Elegante. A dish in the tuff ring behind the playa is the crater of the cone shown below.

The Elegante collapse sectioned Gutmann's Cone, leaving half a volcano exposed in the caldera wall. One of the features of this cone is a very large dike intruded into the cinder. A K-Ar age on the pipe is 460 pm 50 Ka and the age of the dike is 433 pm 120 Ka which are concordant.

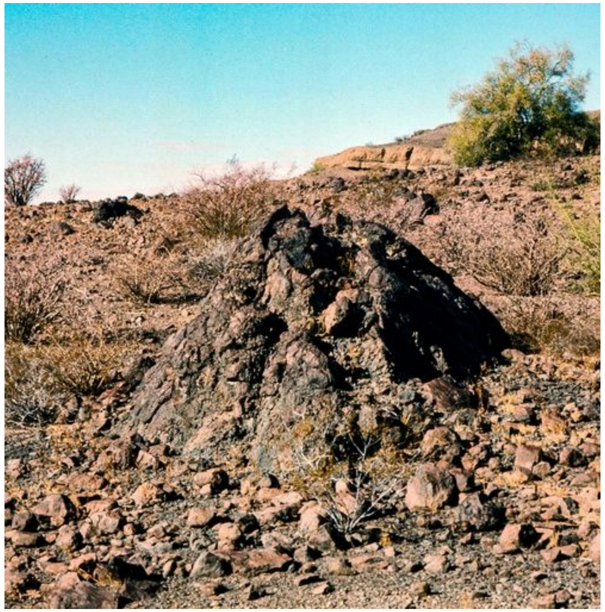


Gutmann’s Cone seen from a mallow-filled playa.

Macdougal maar caldera

Macdougal on the west side has a similar diameter to Elegante but is much less deep and is in a thinner basalt stack.

The interior of the tuff ring was eroded into the maar, perhaps by a boiling lake, leaving a shelf atop the highest lava flow all the way around the crater. Effusion of this flow preceded the steam eruption, and it was still liquid when the tuff landed atop it. Basalt intruded into this tuff as dikes.



Sykes maar caldera

Like Elegante and Macdougal, the Sykes hydrovolcanism was preceded by a normal cinder cone eruption. The vent came out on a ridge-crest and basalt cascaded down both sides of the ridge to form extensive lava flows whose upper reaches are covered with tuff breccia. Part of the cinder cone is the red triangle on the far wall and the south lava is above and behind it to the left. In the distance, between Fried Egg and Macdougal is the north lava which extends 6.5 km and covers 550 hectares.

Sykes looks younger than Macdougal whose inner debris apron, visible in the distance, appears to be more mature.

Molina three-lobed pit

Molina maar is between the Sykes flow and Macdougal. Because Molina's tuff lies atop Sykes basalt on the right side of the picture below, Molina is younger than Sykes.

Moon Crater

Moon has neither tuff breccia nor supporting basalt walls but it does have a central volcano, much like a rebound mountain on a Lunar impact structure. The raised ring around the central playa is covered with large (> half meter) angular, desert varnished blocks.

Cerro Colorado Tuff Cone

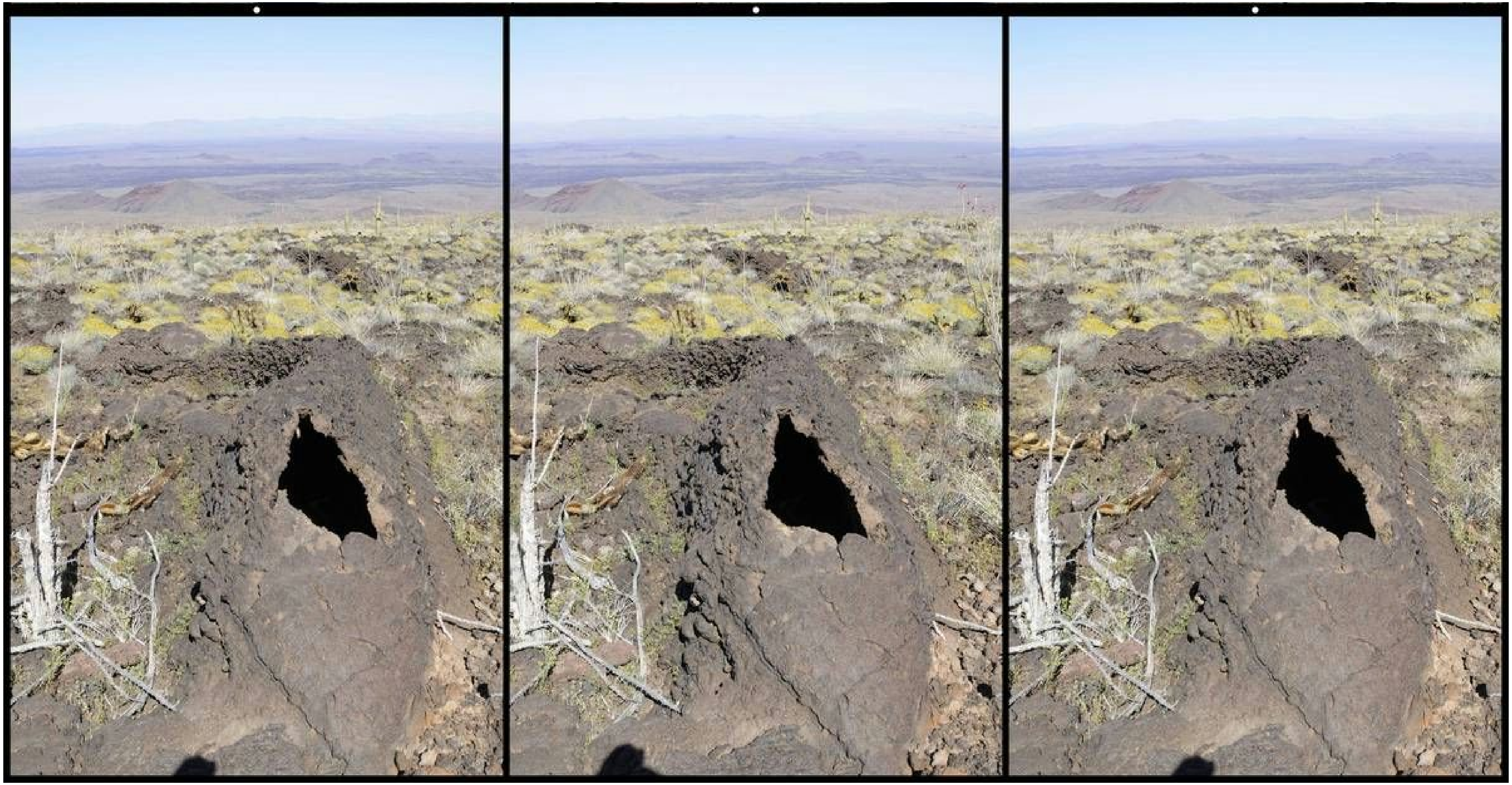
This hydrovolcano erupted into the middle of the northeast side wash, blocking water flow (a rare occurrence) and creating Diaz playa upstream. The tuff ring is asymmetrical and deeply eroded. Unlike with the large maar craters, basalt effusion did not precede tuff generation.

Looking from the opposite direction. The tuff cone is surrounded by an apron that is devoid of regular desert vegetation.

Carnegie Volcano

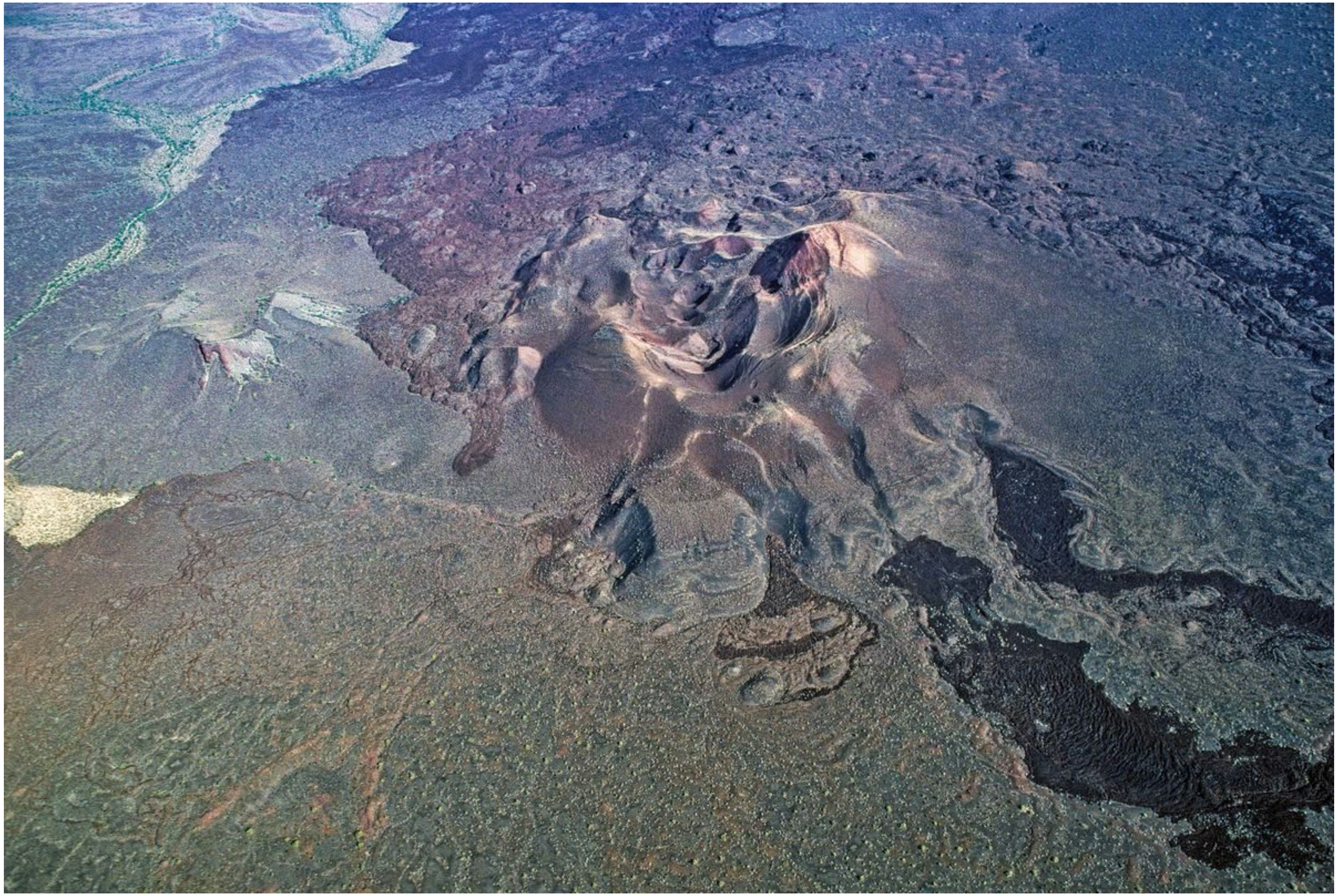
This collapsed cone sits on the northern edge of the irregular summit platform at the top of the trachyte shield volcano. The cone appears to have split in half and part of the northern wall cascaded down the slope in a debris flow, apparently lubricated by a pre-cinder lava flow. After the cinder phase of the eruption, basalt poured from a fissure that extends out from beneath the cone on the left. A dark, lumpy line (red arrow center) is the source of the longest Pinacate lava flow, one that terminates 15 km away on the desert floor. The following stereo images are features found near this fissure in an area called “Iitoii’s Cave.”

Pahoehoe spatter channels near Iitoii's Cave (notice the flat photo - stereo difference)



A hollow spatter tube near Iitoii's Cave.

Tecolote, the volcanic eruption that built itself a cone and then melted it



Strange volcano: some slopes are velvety brown, others are gray. Some flow surfaces are covered with thick cinder, others are bare. Some parts of the cone and of the lava flows are fumarole-stained yellow and red, other parts not. The yellow East Ridge on the right side of the U-shaped breached cone is laced with faults. Each of the three lava flows in the foreground has a valley in the cone behind it where the cinder appears to have collapsed into a void melted in the scoria. These may be secondary lava flows of remelted scoria from the interior of the cone.

The South Bomb Wall has a velvety-brown cast because it is covered with bombs, each of which has taken on a warm toned desert varnish unlike the dark varnish on flow rocks. These solid rocks of half meter and larger diameters are featured in the next several stereo sets. Photographing them is problematic because they all have the same surface texture. This is where stereo is essential to see the details.

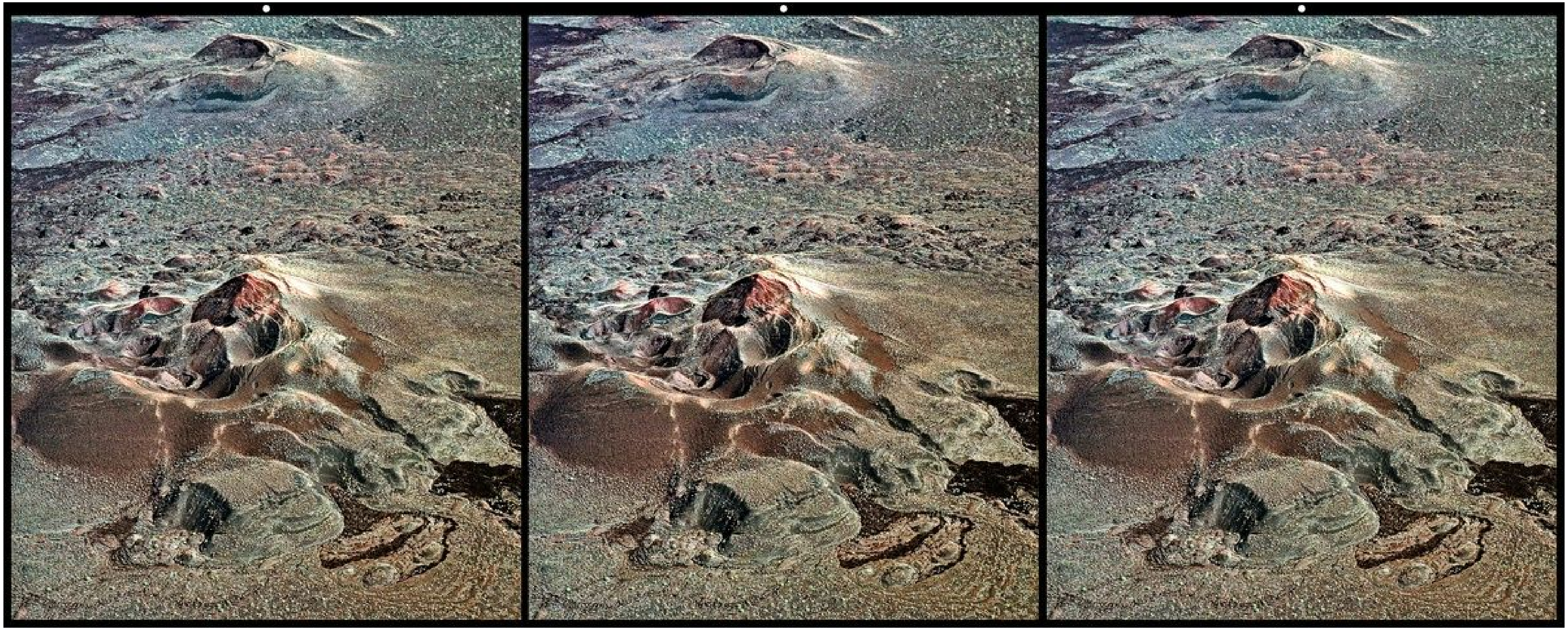
The saguaro is 3 m tall.

More bombs

A solid bomb of 86 cm diameter has a mass of one metric ton.

The Cinder Block

… is an enigmatic wedge of cinder on the south side of the cone. A few large bombs fell on the Cinder Block but not nearly in the profusion found on other parts of the cone. The Valley of A cuts through the entire block but not into the cone, The small deposit of cinder on the distal end of A is a tiny fraction of the cinder removed. Where did it go? The Valley of B ends 5 m from the base of the block and the basalt cascaded down the slope. The valley extends all the way over the rim of the main cone and two sink holes are in the basin over the ridge. C has a minor valley and probably consists of the material melted from the interior of the East Ridge.



Looking up the foreshortened long axis of this breached cone, it is clear that something is just not right. The main cone slopes are a velvety brown, different from the prism of gray cinder at the near base of the cone. Three valleys cut through this prism, each the source of a lava flow, cleverly named A, B, and C. A has the deepest valley and is decorated with cinder on its distal end. This is the high viscosity “anosma” flow.

Prominent faults are visible on the East Ridge in the center of the photograph. That ridge is a graben on top. A band of thick cinder covers the Q flow in the distance.

The Anosma Flow - in stereo, these images of the A flow show more than a jumble

The graben in the melted East Ridge

All of the rock in this ridge is hydrothermally altered, in some places it's a deep red color. The prominent fault scarp that sweeps across the view from lower left into the center is 2 m high and vertical, unlike most of the faults, because the faulted scoria is indurated and remains mechanically strong after 28,000 years.

All of the scarps on this side of the ridge are down on the uphill side, the same is true on the less photogenic outer slope, and in the distance, the skyline forms a broad "W." It appears that the interior of this existing ridge shrank, allowing the ridgecrest to subside as a void was created. The most likely cause is melting compaction of recently erupted, still hot scoria from the heat that fumaroles brought into the ridge after the main eruption. The melted rock was a secondary magma that escaped along the south base of the cone to form the cinder-free flows. This secondary magma was hot enough to melt the scoria above it causing the surface to subside into the three prominent valleys.