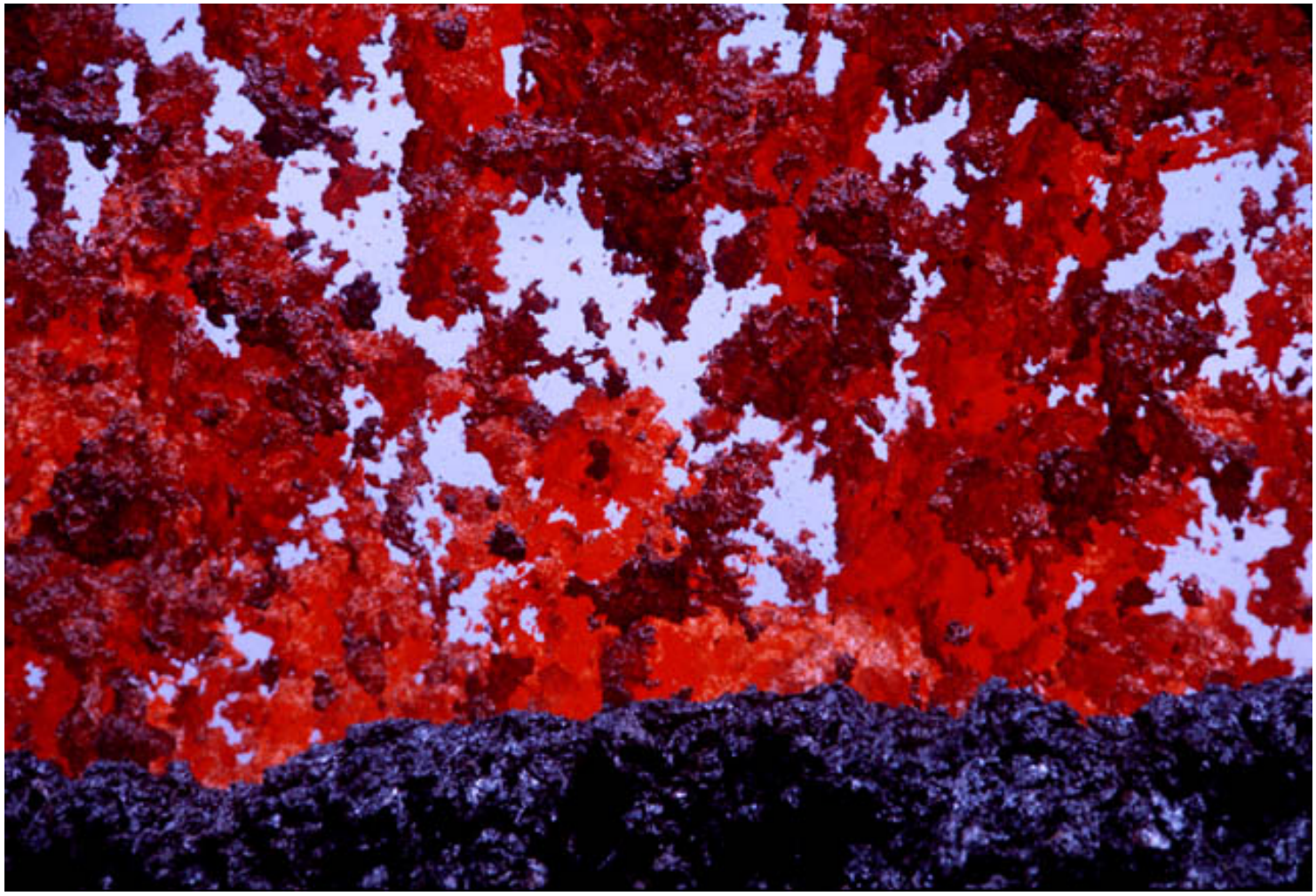
The SUPERVolcano



beneath the San Juan Mountains

How did the magnificent mountains of the San Juan country form? How were they born, and what will become of them?

The San Juan Mountains are the remains of gigantic volcanoes. But those giants sit atop the crater of one single Supervolcano that dwarfs them all…

A Supervolcano is thought to be the incredibly violent eruption of a mantle plume or “hot spot” deep within the Earth, many times more powerful than normal volcanic eruptions.

Volcanoes can be unreasonably beautiful…

Destruction and violence create new landscapes…

The fury of Mount Etna's fires built its mountains, and the vast amounts of exploded ash and rock, thrown from the volcanic throat, enrich the soil and fields of the land around its base.

The fire rains minerals on the land, feeding life…

Volcanoes create weather; lightning and rain are spawned by the violent eruptions, and volcanic ash clouds can cool the entire planet…

So, what is the San Juan Supervolcano? Is it just a bigger pile of frozen lava than its smaller siblings?

Volcanoes of every size have some things in common. All of the volcanoes of the San Juan Mountains were born of titanic forces within the Earth. Our planet's outer crust is cool and brittle, but beneath it lies the mantle, where rock melts and rises upward.

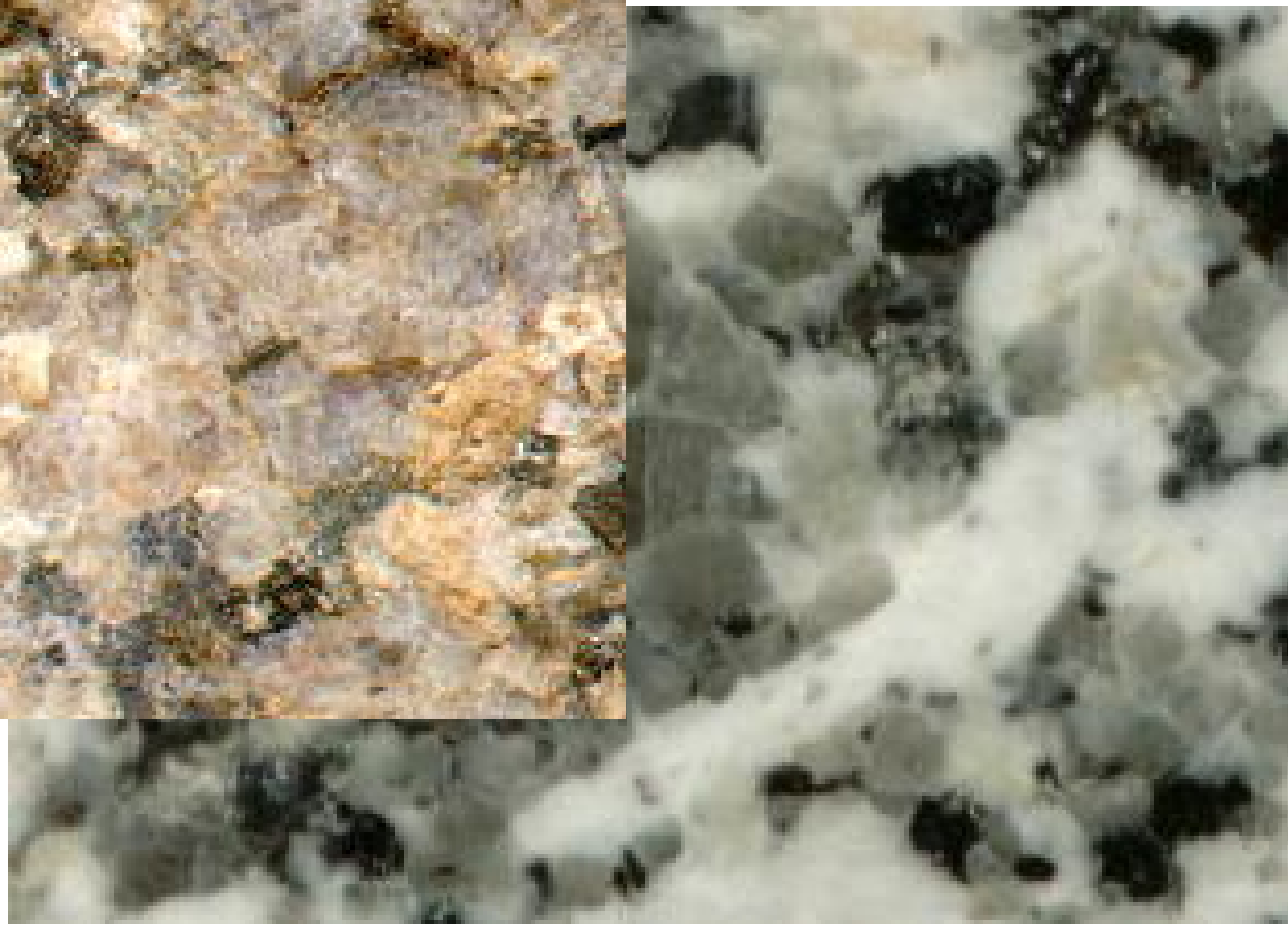
The center of the Earth is a solid ball of mostly iron, surrounded by a larger ocean of molten iron and silicon and cobalt. Seething at nearly 5,000 degrees and rotating slightly out of phase with the planet, this is where our world's magnetic field is created.

70% of the Earth is made up of the mantle, a shell of dense rock containing the minerals zoisite, garnet, olivine (the gemstone *peridot*), and corundum (the gemstone *ruby*),this rock is a beautiful mass of green and red crystals called *peridotite*.

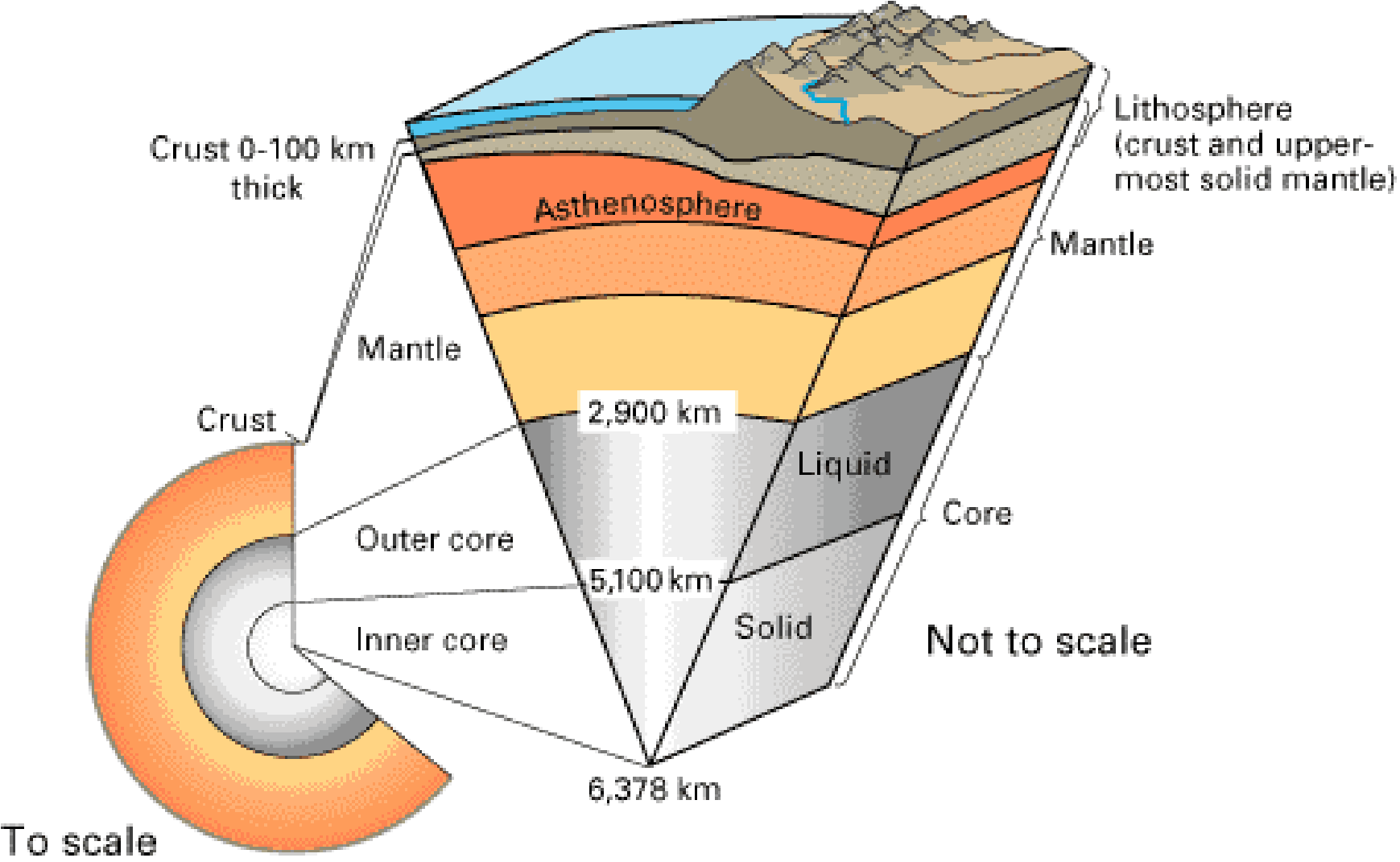
Partial melting in the uppermost layer of the mantle creates magma, liquid rock, which forms *basalt* when cooled. This heavy green-black stone makes up the floors of our oceans.

When basalt partially melts, it cools into a group of lighter rock types which make up the continents…

This rock type is large and varied, but the main variety is called granite, made up of Quartz and Feldspar and Hornblende and Micas. Because granite is lighter than basalt, the continents “float” above the ocean floors.

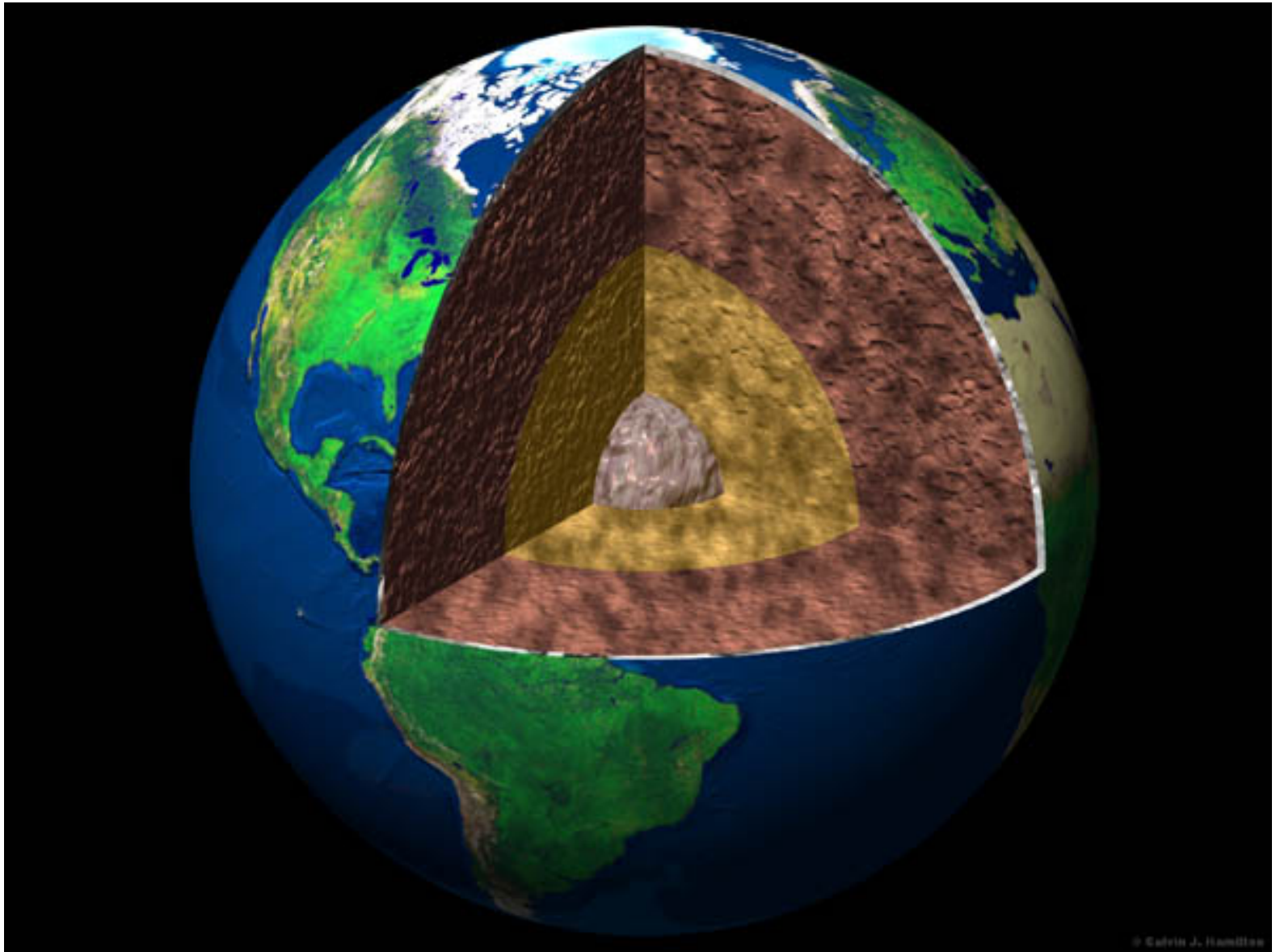


Together these melt-derived rocks make up the Earth’s outer layer…



The Lithosphere is the rigid outer surface of the Earth, made up of the crust and the uppermost mantle. This is the realm of the tectonic plates, the brittle, fractured shell pulling the oceans and continents in endless motion across the face of our planet, riding on the heat of the mantle. If you could slice open the Earth…

…you could see the internal structure of the planet. The Earth is a heat-driven machine, separated into layers of metal and rock, each acting in concert with the other, constantly changing the surface on which we live.

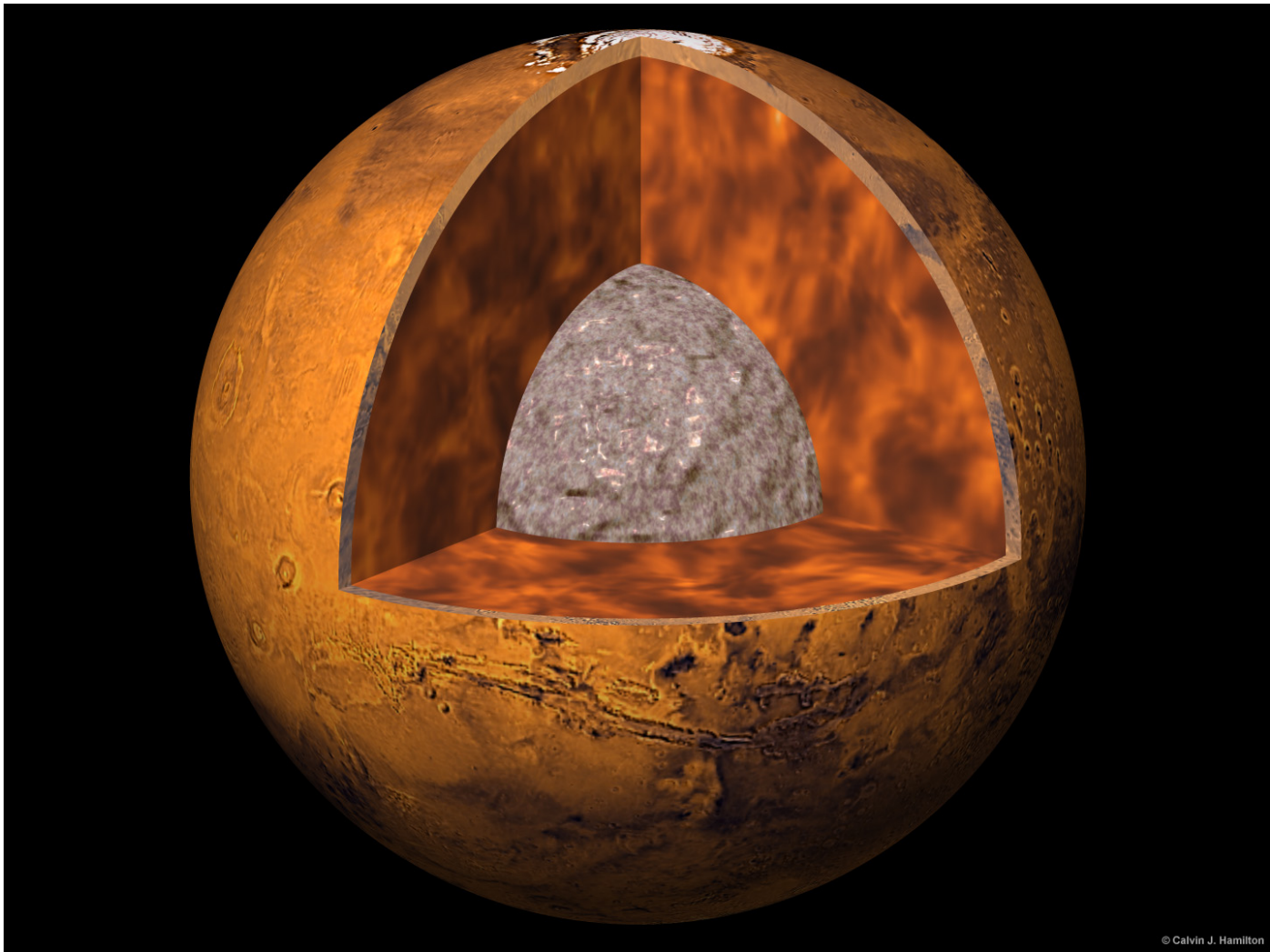


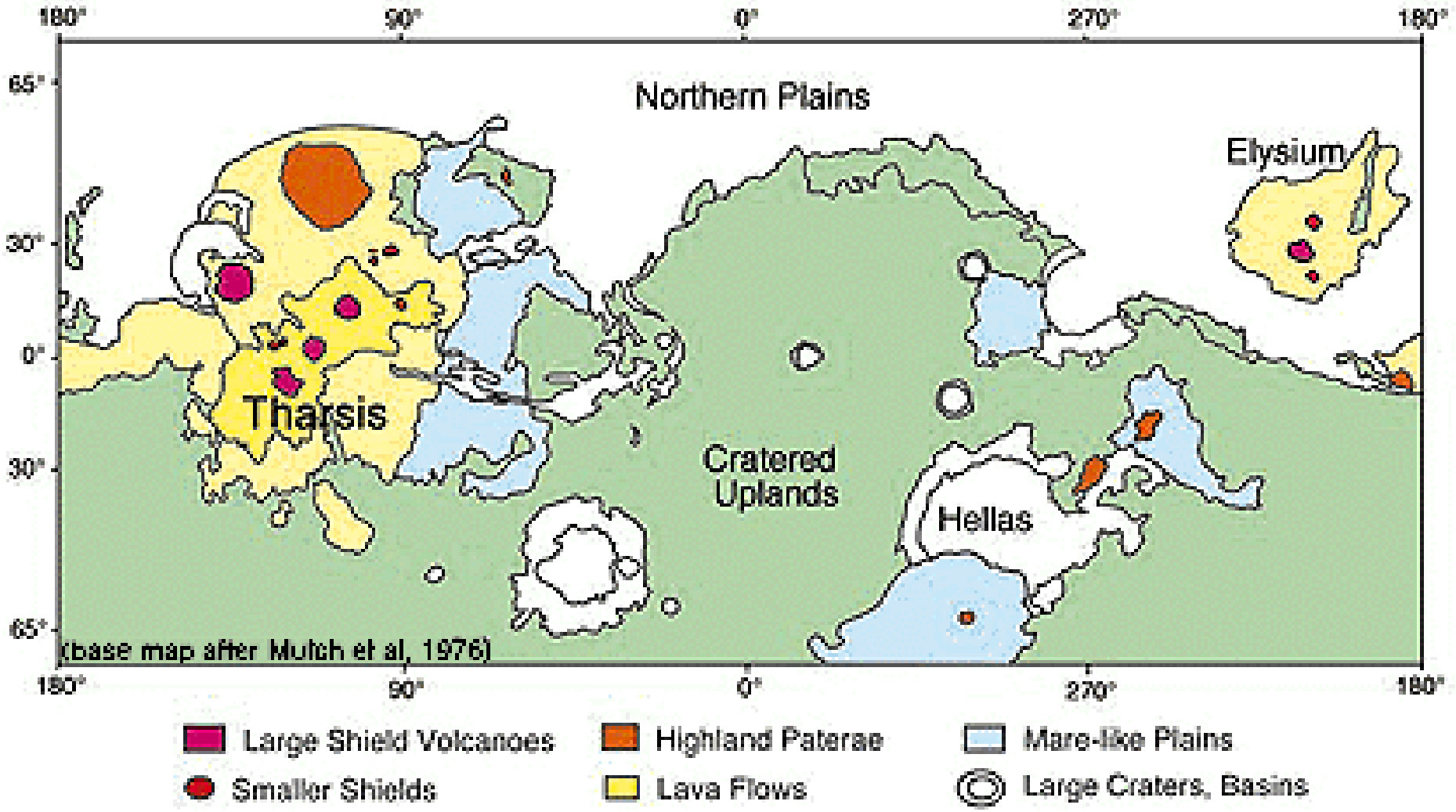
Earth is not the only planet with volcanoes. Mars has several, all much larger than Earth's. The greatest is called Mount Olympus, and it towers some 12 miles high. The lesser gravity of Mars allows volcanoes to build over twice as high as the highest Earthly mountains.

Martian volcanoes, however, all seem to be extinct…

It is likely that Mars has lost most of its internal heat, the force which drives the movement of tectonic plates and the creation of volcanoes. Without the heat to melt the rocks of Mars' upper mantle, volcanoes die, starved of magma and energy.

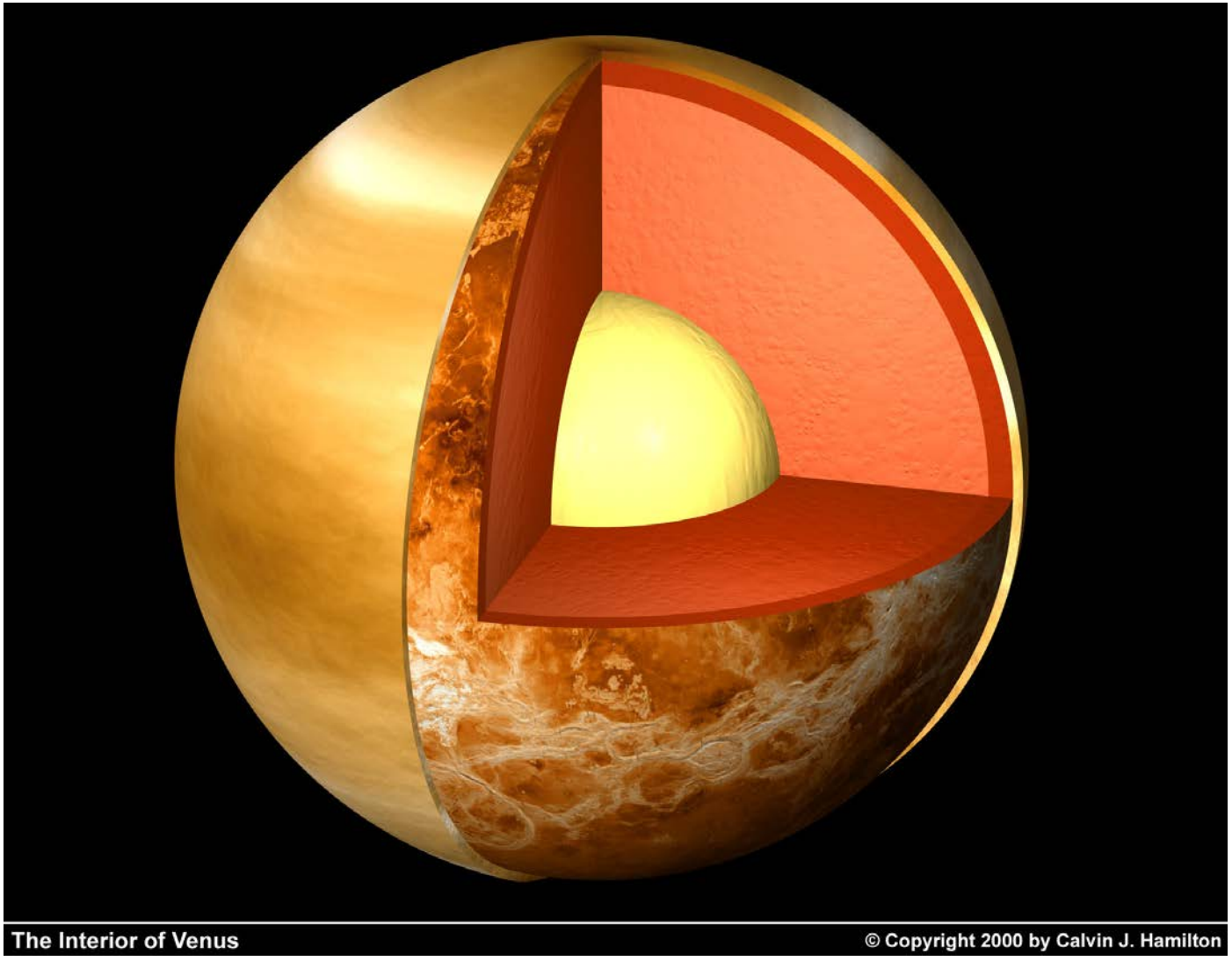
But the huge volcanic piles remain. Mars has almost no liquid water and little atmospheric energy to tear them down, unlike the Earth's active and violent surface.





So the evidence of Mars' volcanic past is plain to see. Geologic maps of the Red Planet show major volcanic centers, such as Tharsis, where Mt. Olympus, a true Martian Supervolcano, towers above the land. But no longer does the ground shake from eruptions on Mars…

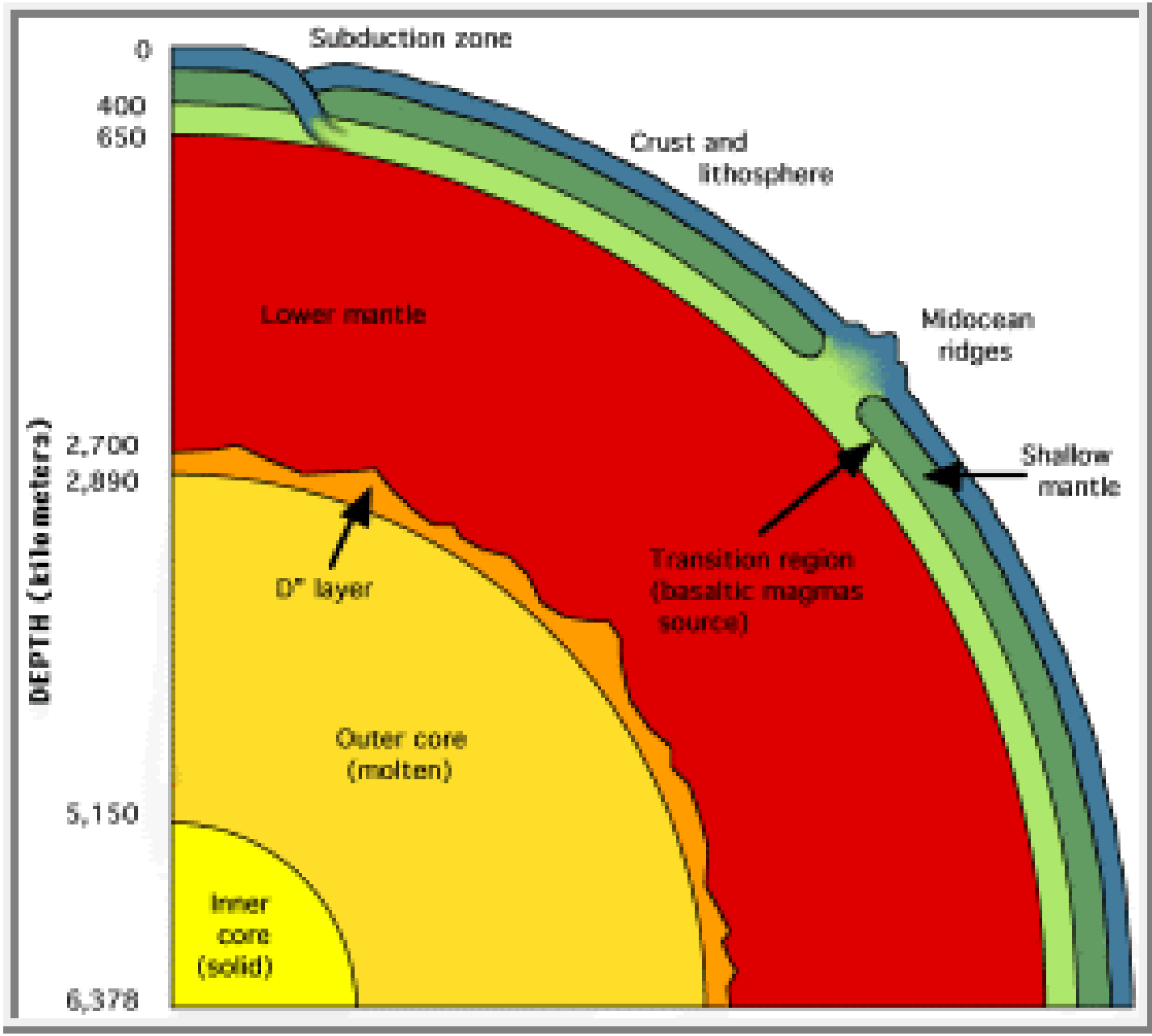
Venus is another planet of volcanic fire. Beneath its clouds of sulfuric acid lies a surface torn by the ultimate in volcanism…



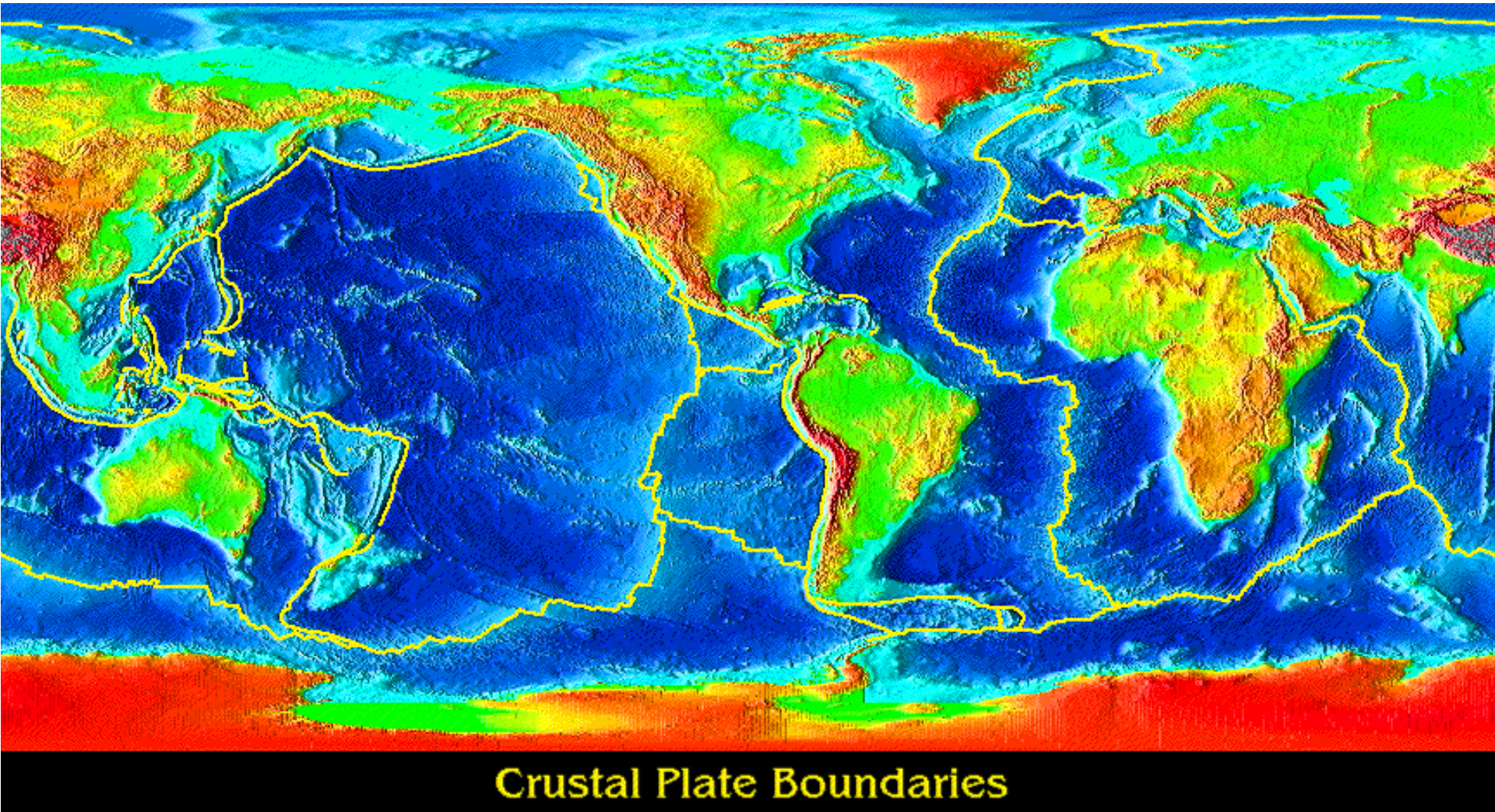
Sometime in the last 250 million years, Venus seems to have suffered an overwhelming volcanic catastrophe: the entire surface of the planet seems to have melted, to have been engulfed in molten rock. Whatever Venus' surface was like before, there is nothing left of that past. Venus today seethes at 700 degrees in an acid wind.

Heat is the force that drives all of the Earth's volcanic activity.

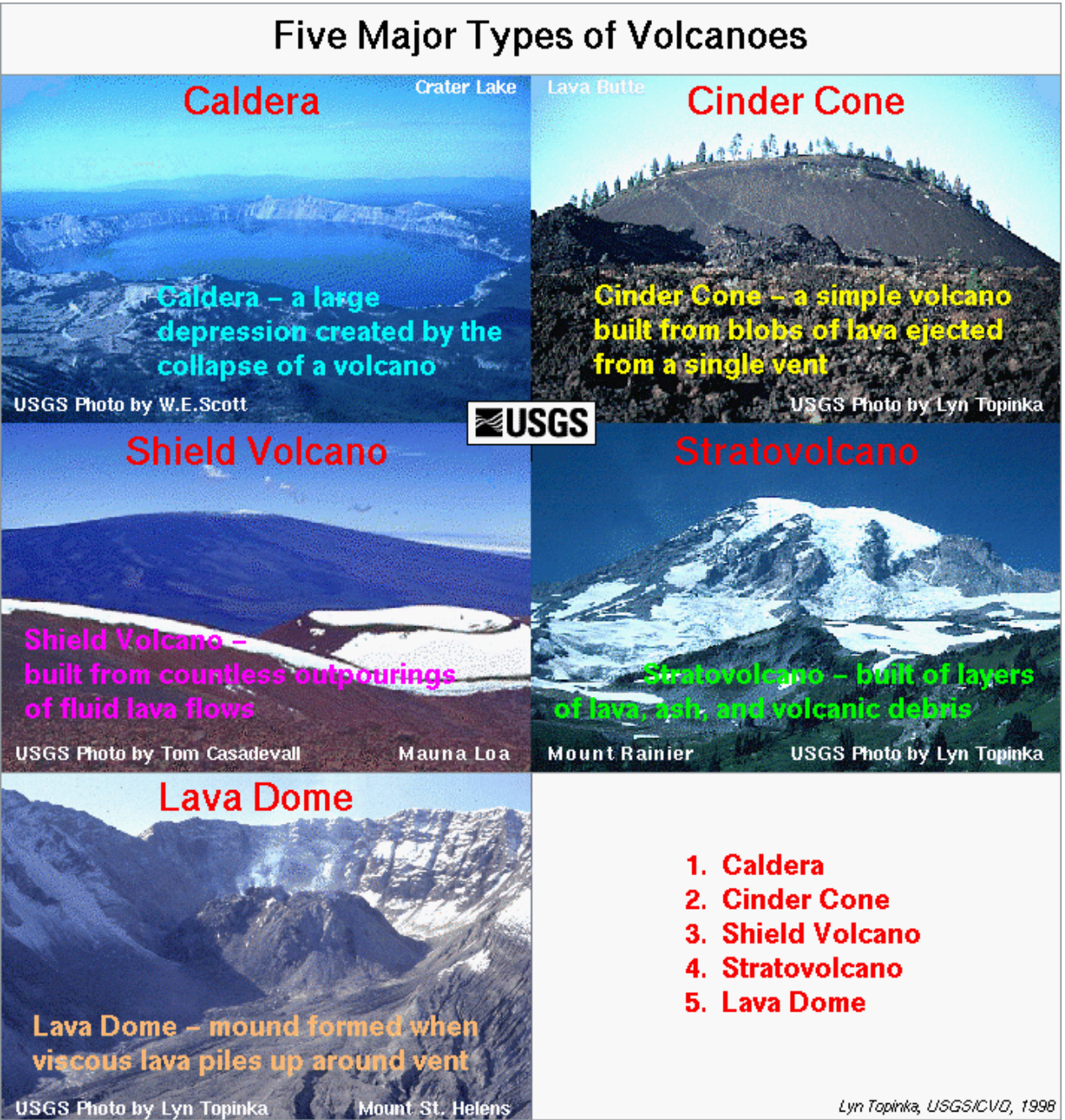
Heat from the Earth's formation and decay of radio-active elements bleeds from the core and the mantle of our world, melting rock in the uppermost layer of the mantle. That molten rock, called magma, rises under the crust, breaking through to create "normal" volcanic eruptions, and spreads out to drag and shift the continents around. But- that's **not** how a Supervolcano forms!



The Earth's surface is a mosaic of many tectonic plates, some bigger than entire continents, some smaller than states. Their motion, grinding past one another, crashing into and sliding under each other, driving down and melting, unleashes the terror of earthquakes and creates the titanic chains of mountains and volcanoes across the Earth.



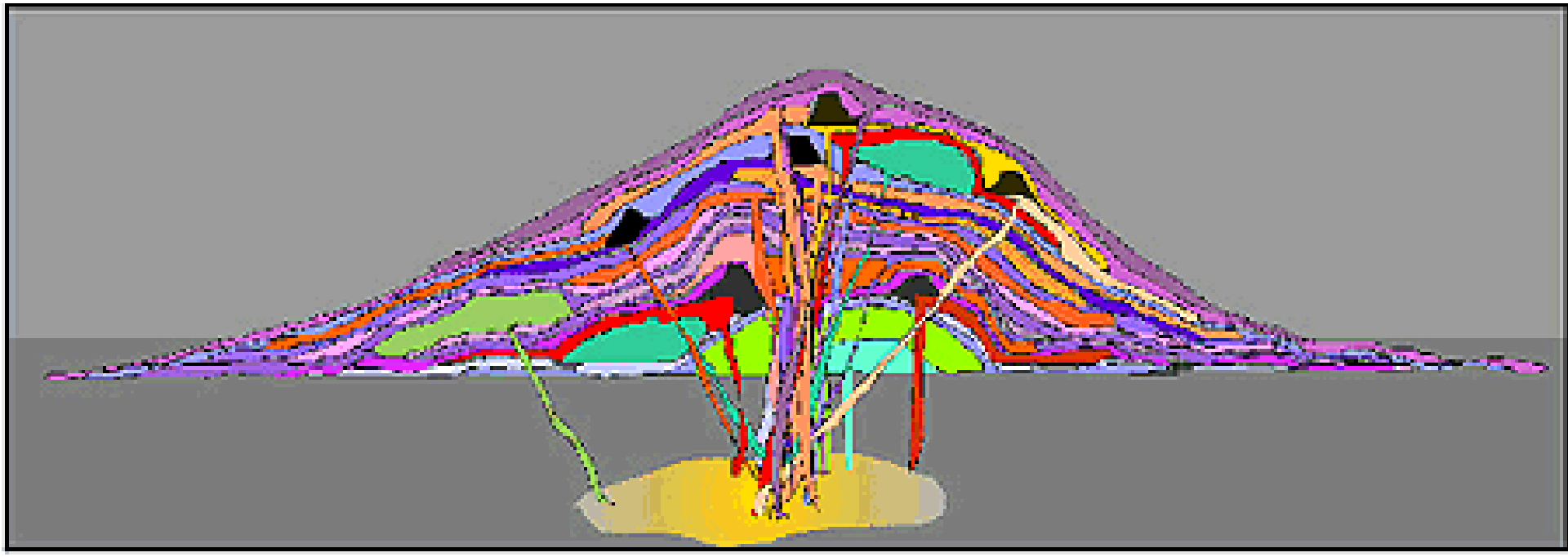
The U.S. Geological Survey classifies volcanoes according to these five major types.



The San Juan Mountains contain Stratovolcanoes, Calderas and Lava Domes. These three types have one factor in common – extreme violence during eruptions. Stratovolcanoes are towering piles built up by explosions of rock and ash and lava flows; Calderas are gaping wounds created by the emptying out of a volcanic magma chamber; and Lava Domes are plugs of magma that rise and collapse in avalanches of fire and ash.

But does a Supervolcano fit in this system? Not really- these monsters are more eruption than mountain. But they are cousins to normal volcanoes…

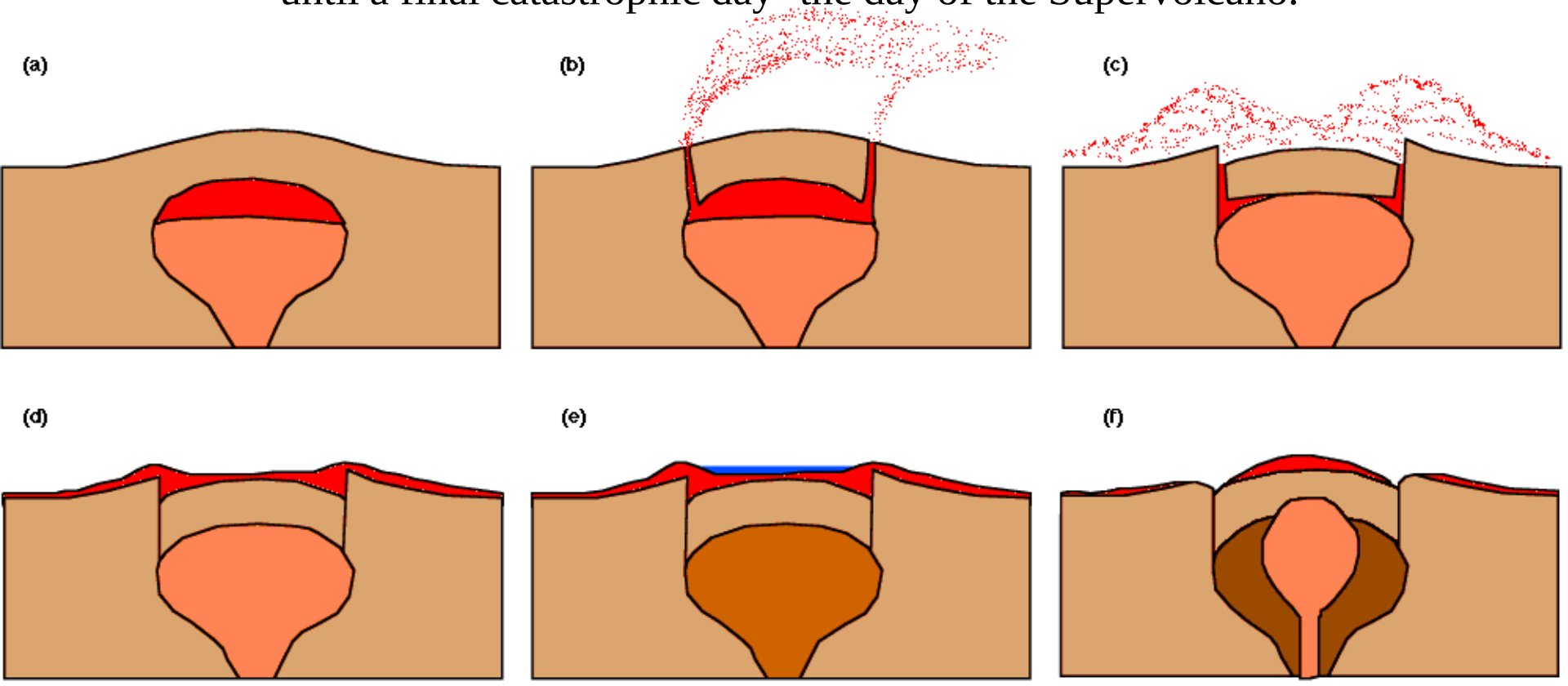
A typical volcano in the Four Corners was a stratovolcano: thousands of feet high, built of complex layers of ash, rock, lava, and collapsed lava domes. Numerous pipes and fractures feed magma to the sides and top of the volcano, from one or more chambers of molten rock beneath. Such volcanoes can rise fast, and can lay dormant for hundreds or thousands of years between eruptions.



The San Juan volcanoes were mostly of this type. They rose some 30 million years ago, fed by the energy beneath the Rio Grande Rift, a crack in the crust caused by upwelling magma in the upper mantle. This energy broke through the crust and created the San Juan Volcanic Field and its spectacular volcanoes, and provided the inconceivable power to create the Supervolcano that destroyed these volcanic mountains in one tremendous Earth-shaking blast.

A Supervolcano doesn't build a mountain- it destroys mountains. Its eruptions create calderas- vast craters, holes in the Earth. Normal caldera eruptions occur when the pressure below a volcano is too great to stay contained. Fractures allow pressure to escape, but weaken the overlying rock. At some point, the entire magma chamber explodes upward, blasting the volcanic mountain into the air. The debris settles back into the crater, filling most of the empty chamber. Lakes and forests cover the interior, until the pressure again builds, destroying the old and creating new volcanoes and calderas. This cycle repeated many times in the Four Corners…

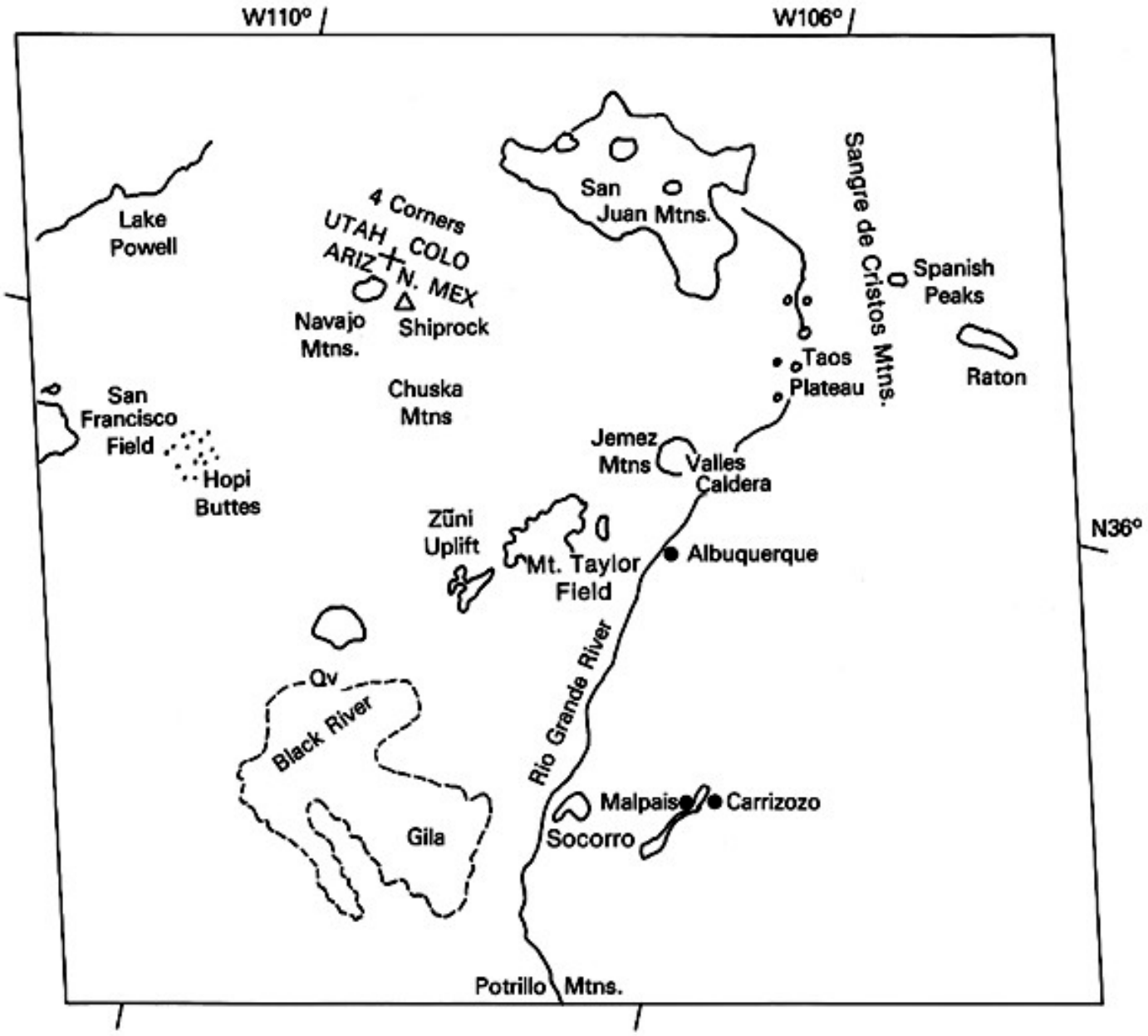
until a final catastrophic day- the day of the Supervolcano.



A map of today's active or potentially active volcanoes shows nothing at all in Colorado, and only two volcanic fields in Arizona and New Mexico. Even though it is not active today, where is the hole, the vast caldera that should be there?

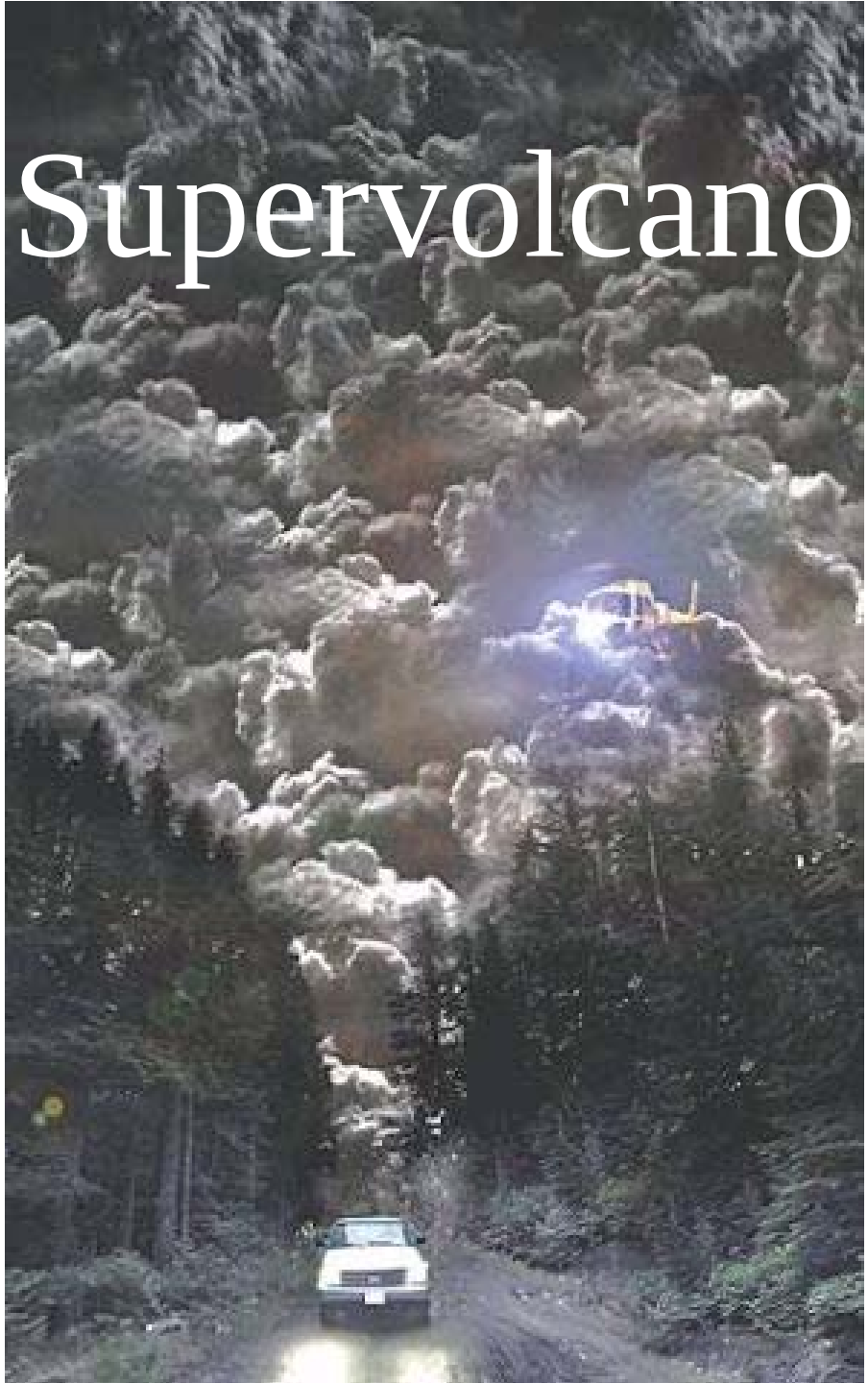
To find out, look at the landscape 30 million years ago…

The Four Corners was a place of active and violent vulcanism.



All of the areas shown here were actively erupting 30 million years ago; some, such as the Malpais, have erupted as recently as a thousand years ago. The largest concentration of volcanoes was the San Juan Mountains at the northern end of the Rio Grande Rift. Here was born the most violent explosion on Earth, forced up from below by titanic pressure and heat…

Supervolcano



Volcanic violence is hard to grasp…

Normal or Super, what does it mean when a volcano erupts?

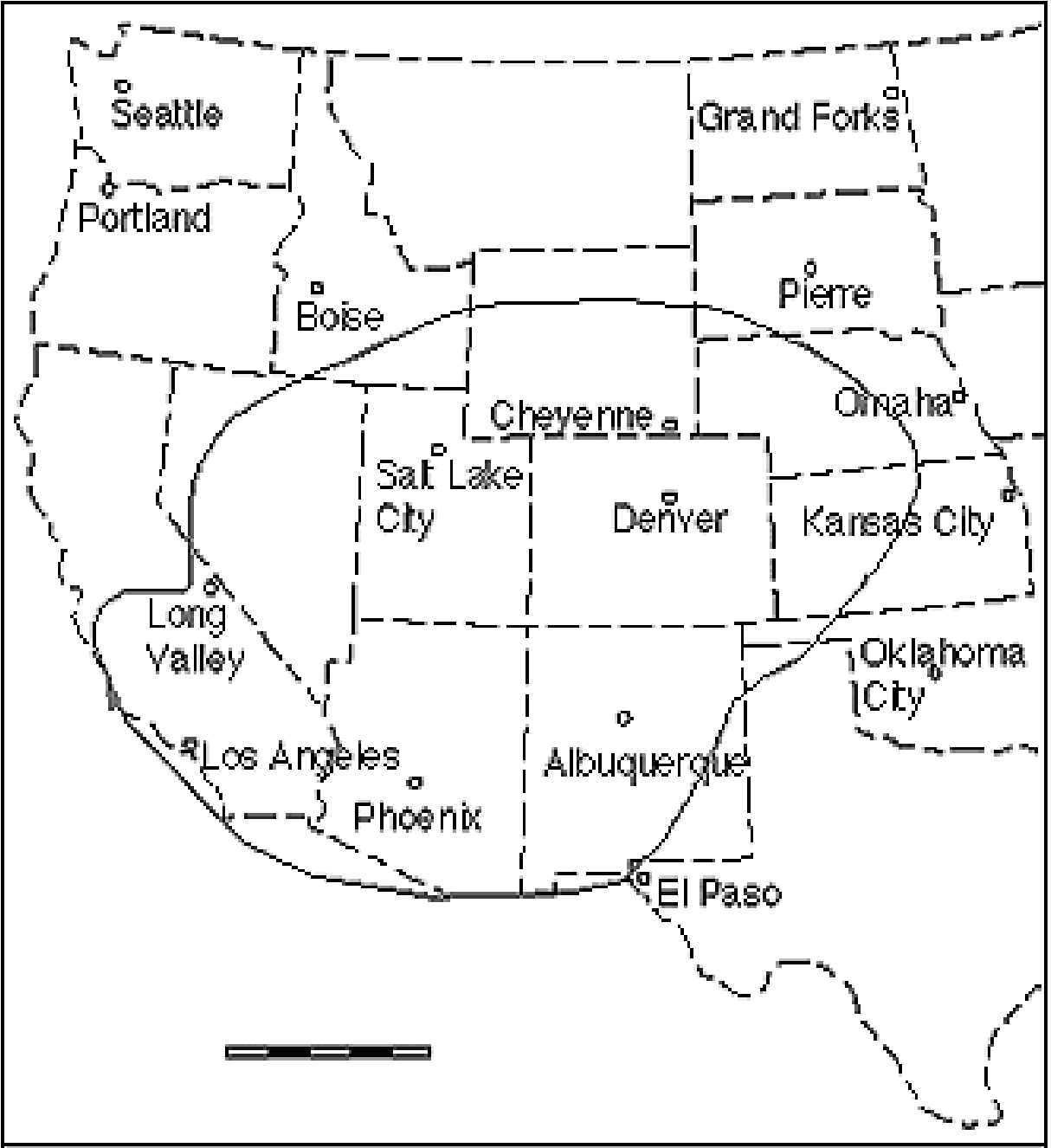
This is Mount St. Helens; the cloud of rock and ash towers thousands of feet into the air, and will later collapse in a pyroclastic flow of tremendous destructive power. Such eruptions were common events in the ancient Four Corners.

But it is worth noting that Mount St. Helens, as impressive and deadly as it was, was a minor eruption. What went on in the San Juans was thousands of times more violent. Some eruptions scoured life and seared earth over areas the size of entire states, tens of thousands of square miles burned and buried beneath uncounted tons of ash and lava…

Was this what things were like at the start of a Supervolcano eruption?

Could something that huge really happen? Geologic evidence shows that even “normal” volcanic eruptions can devastate vast areas. The rocks in the foreground stream bed were erupted from the volcano in the background in a pyroclastic flow, a glowing avalanche of rock and gas moving at more than 60 miles per hour and burning at 300 degrees. This eruption was even smaller than Mount St. Helens’…

What was the effect of a truly Super eruption?



Distribution of Bishop ash beds from eruption at Long Valley caldera. From Izett and others (1982).

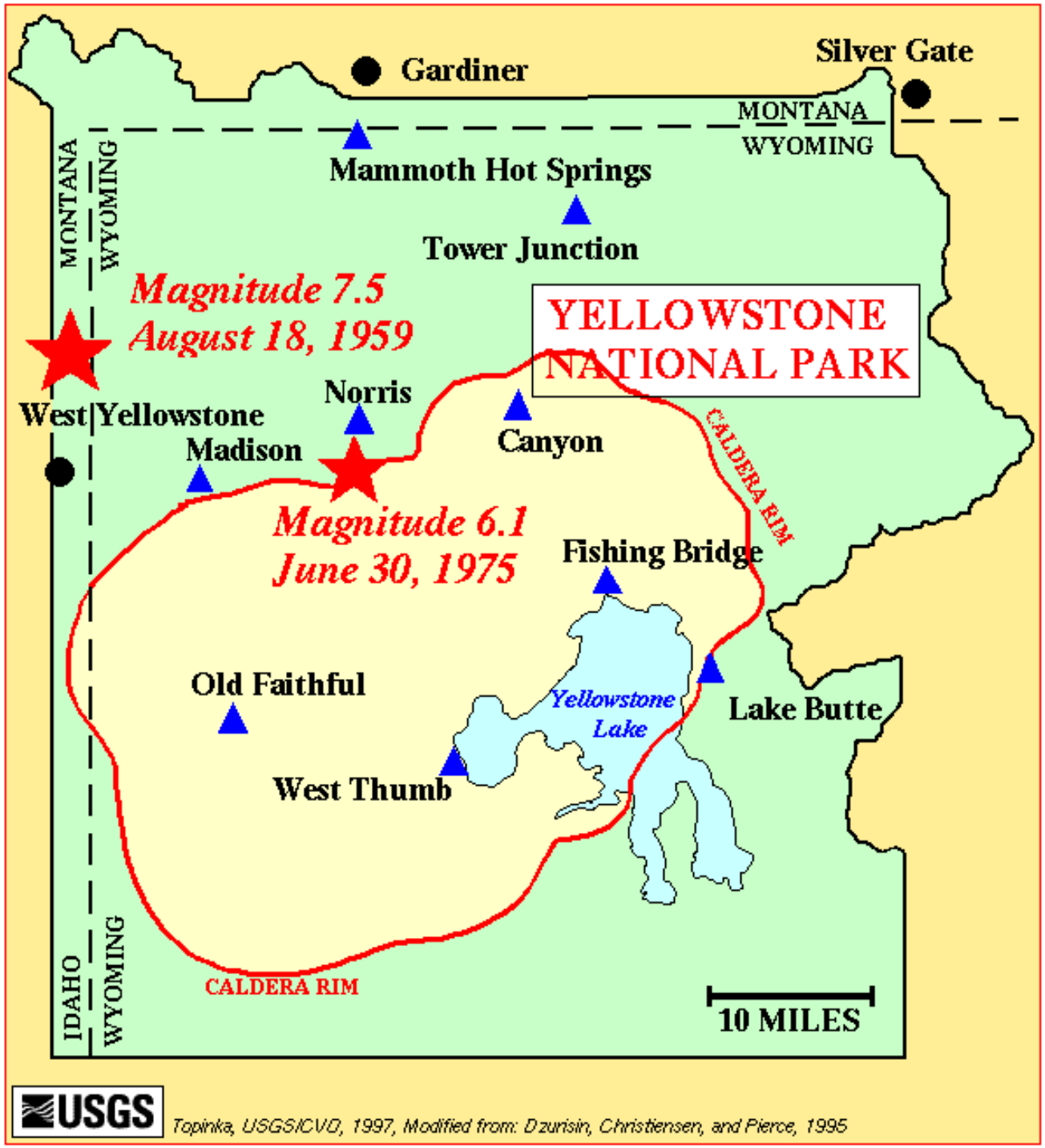
This map shows the extent of volcanic fallout from the Long Valley caldera eruption some 760,000 years ago.

In addition to the physical destruction of everything near the volcano, the ash cloud would have caused forest fires, clogged streams, caused floods and devastating mudflows, suffocated animals, and buried plants. The ecology of the southwest would have been disrupted for decades, and the world's climate would have been cooled for years.

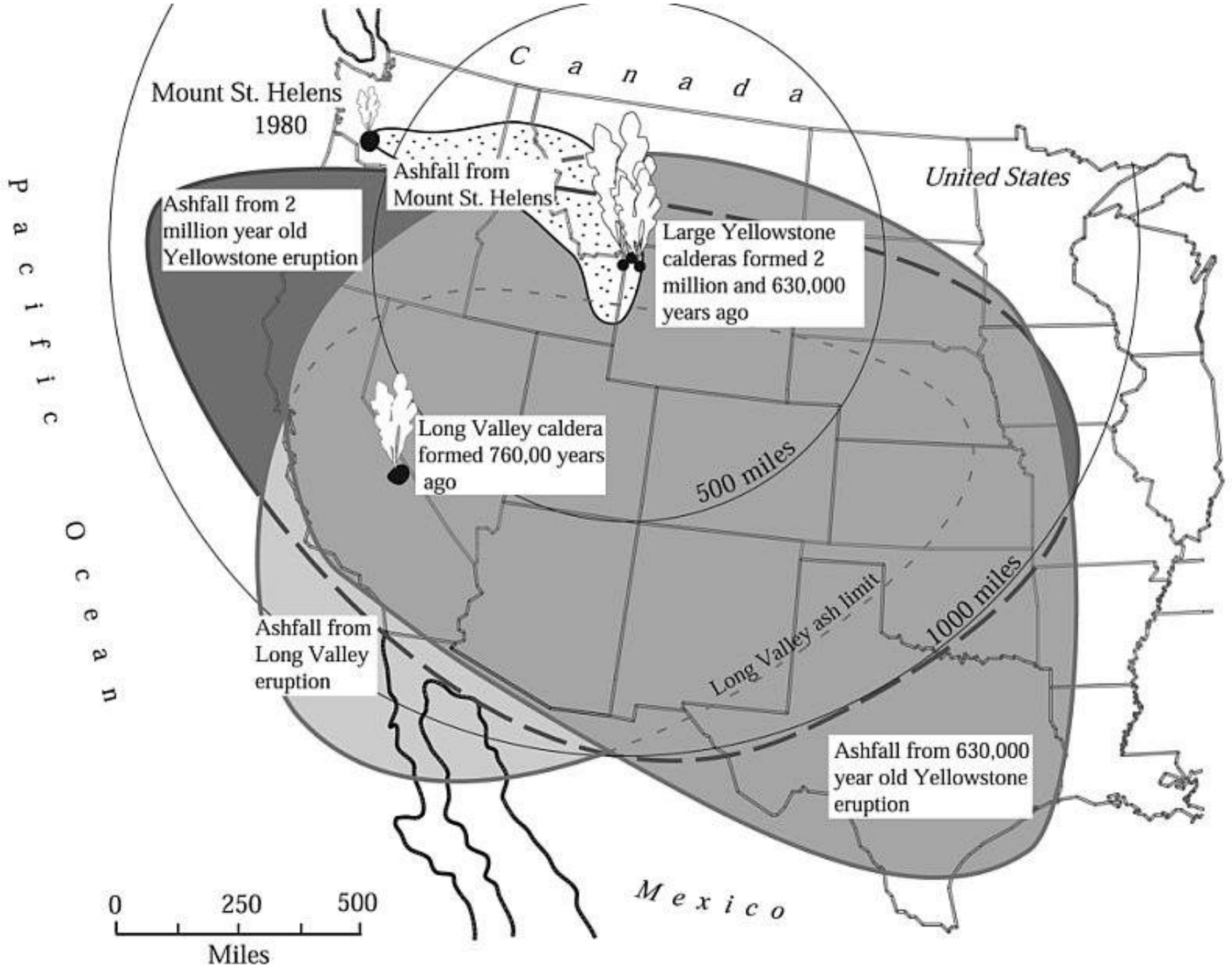
And Long Valley was not the ***largest*** known eruption, either…

Until a few years ago, Yellowstone National Park's caldera, outlined in red, was the largest single volcanic eruption known on Earth. Around 600,000 years ago, it blew out a hole nearly 45 miles across, throwing out over 400 cubic ***miles*** of rock.

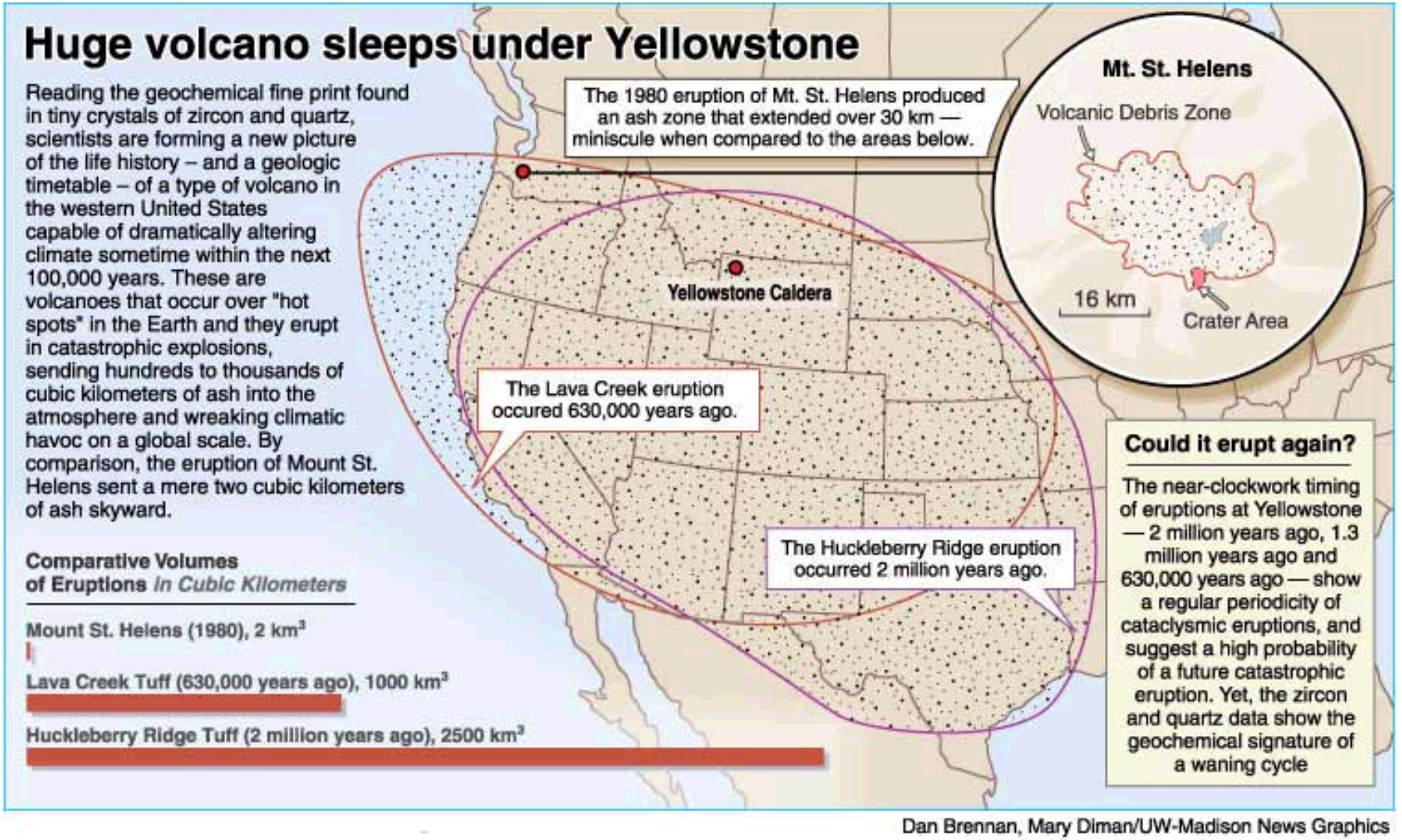
The sulfur vents, hot springs, mudpots, fumaroles, geysers, and earthquakes which still steam and shake the land show the power of that titanic blast so long ago; the earth is still settling down and cooling from the explosion.



What goes up… must come down! Where does all that rock and ash fall?



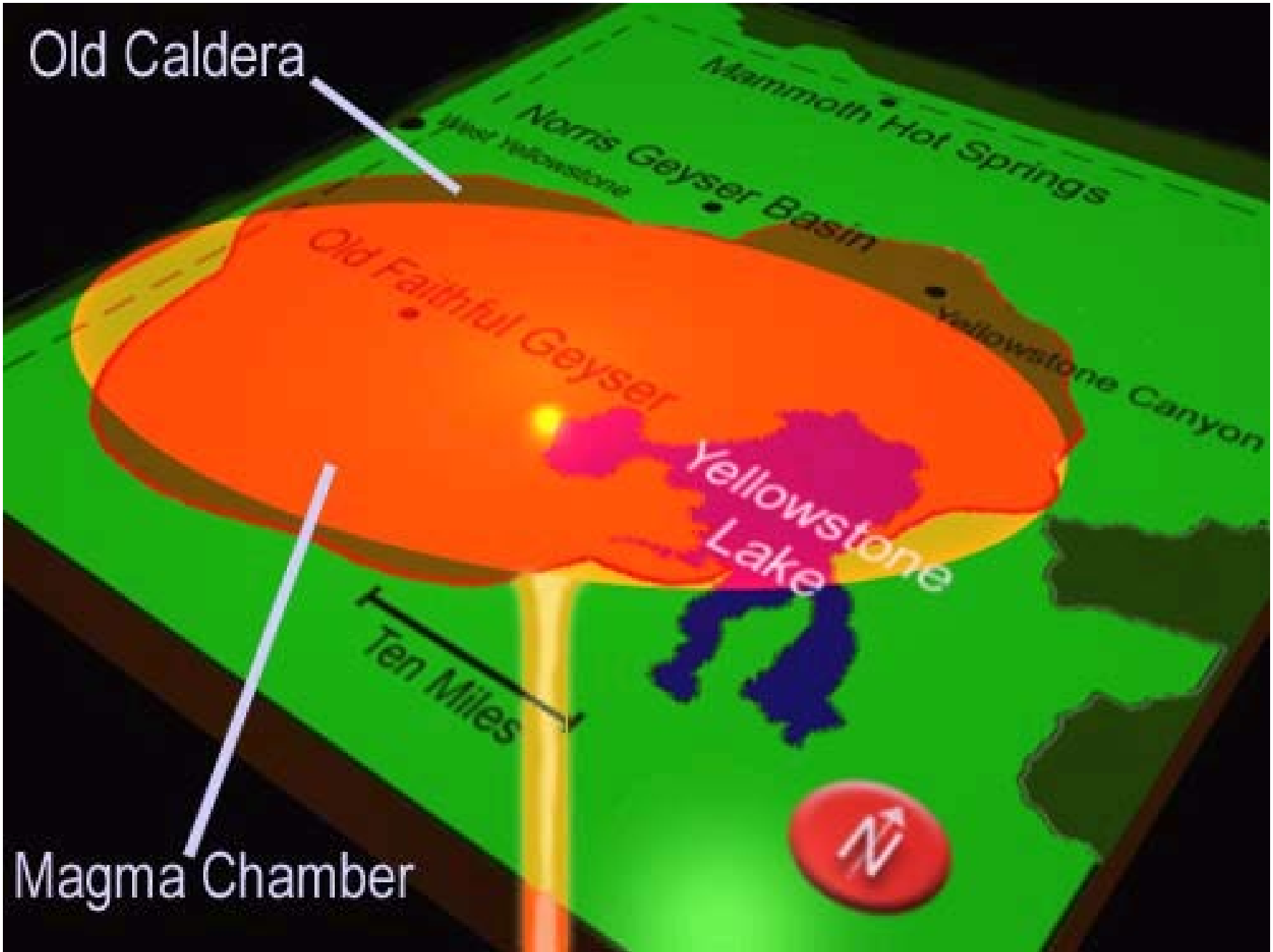
This circle is 600 miles in radius, centered on Yellowstone's caldera…

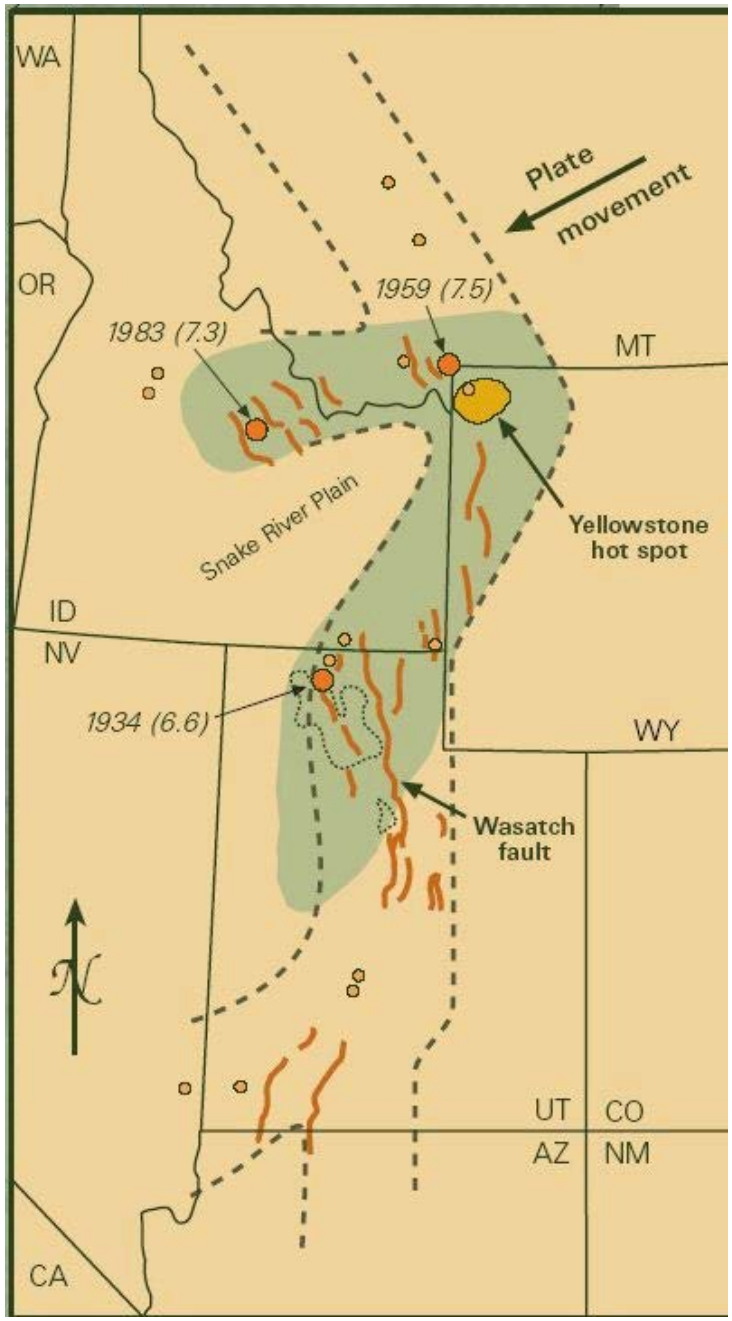


Dan Brennan, Mary Diman/UW-Madison News Graphics

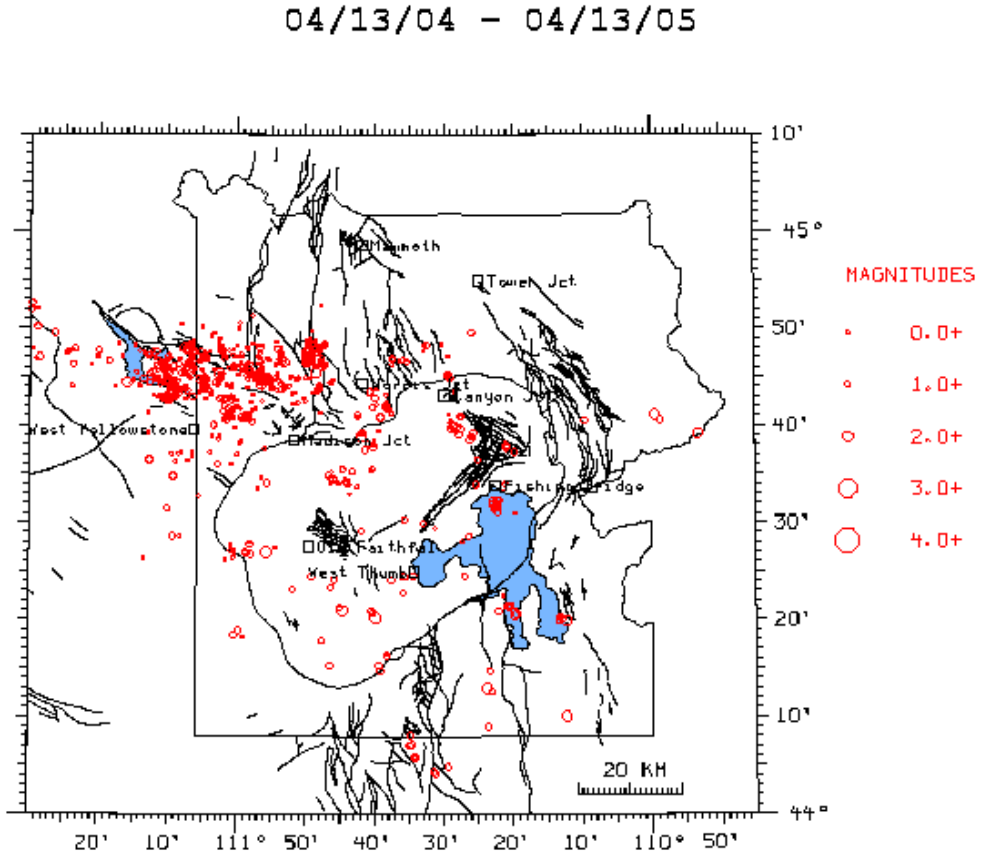
Yellowstone is among the world's first identified Supervolcanoes, with the results of several known mega-eruptions under its active and beautiful surface… eruptions that dwarf anything modern humans have experienced.

A monster still lurks beneath the park…waiting to explode?





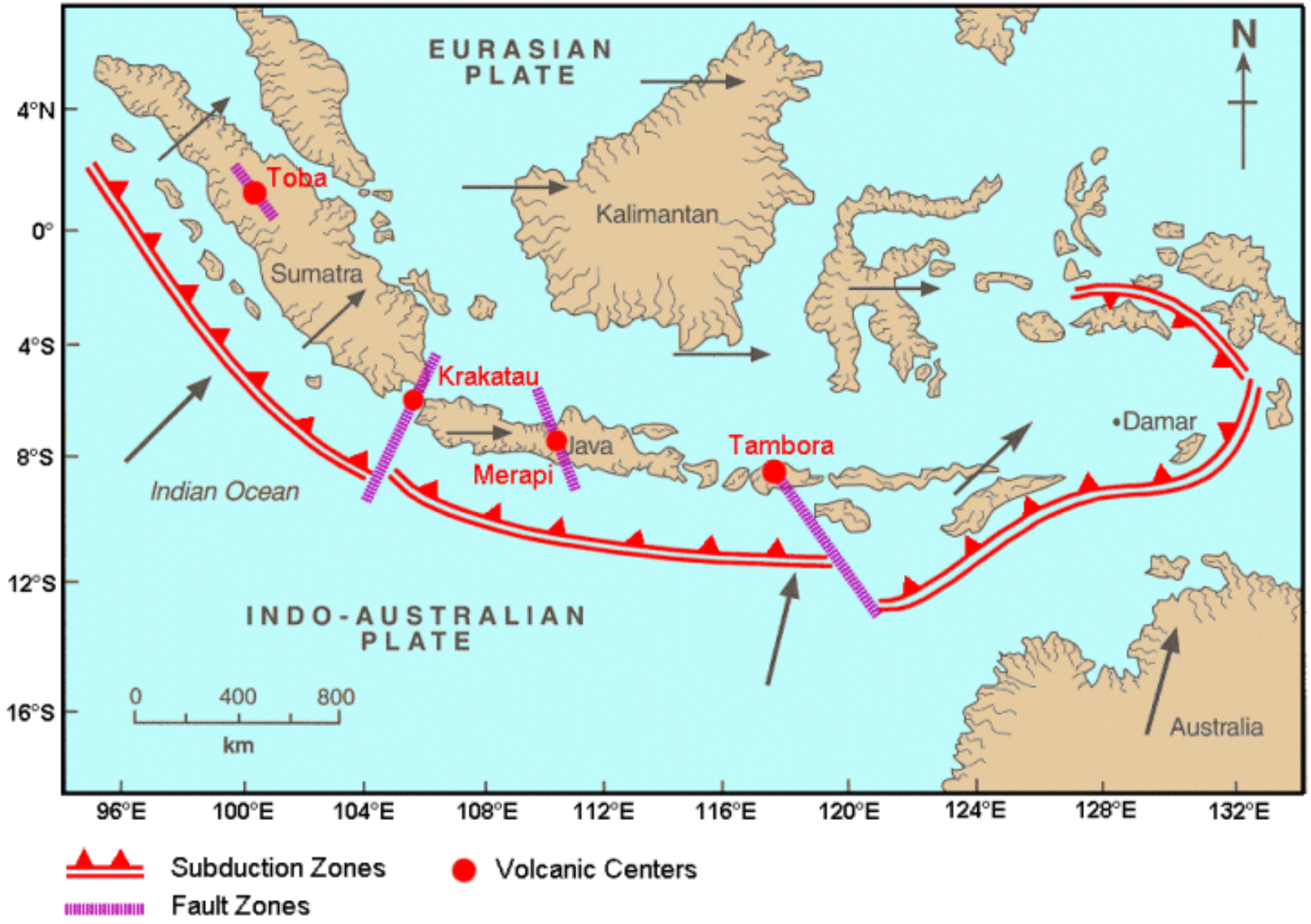
Yellowstone's monster, the origin of its Supervolcano, lies beneath the moving North American tectonic plate. Past eruptions clearly show the periodic trace as the hot spot punctured the crust of the earth. The mantle plume's eruptions track the changes in motion of the plate above it, and earthquakes add to the picture of the hidden threat still seething underground.



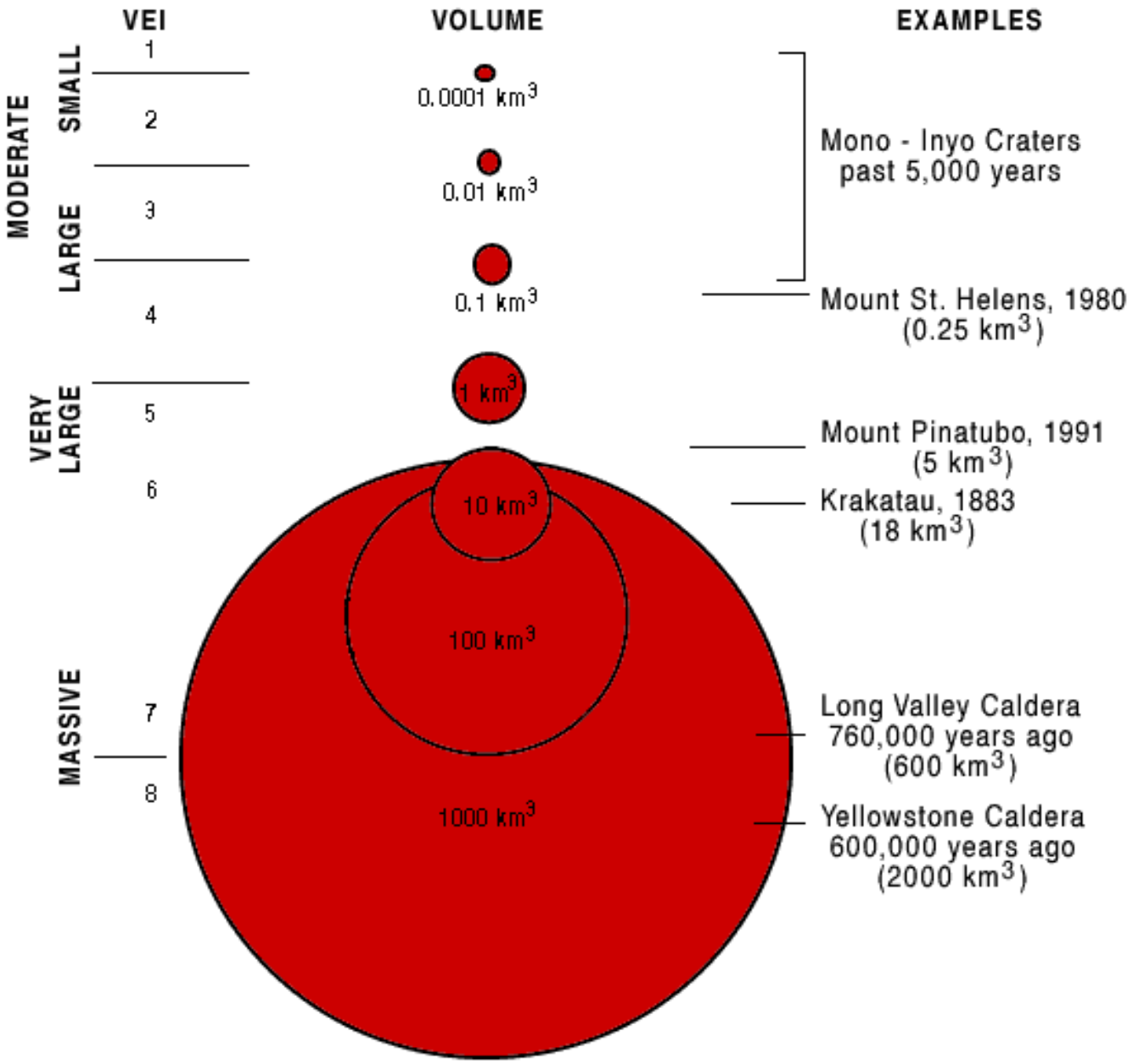
And Yellowstone isn’t alone. Other Supervolcanoes dot the Earth. Most are extinct, but they have had profound effects on our world’s history.

Valles Caldera, New Mexico, still retains its central crater.

Indonesia's Toba eruption 70,000 years ago came close to driving the human species to extinction. The human genome shows clear evidence of descent from only a few thousand survivors of that ancient cataclysm, down from millions of humans before the eruption. Climate disruption was the most likely cause for the drop of population.



So- in the world of volcanoes… How big is BIG?



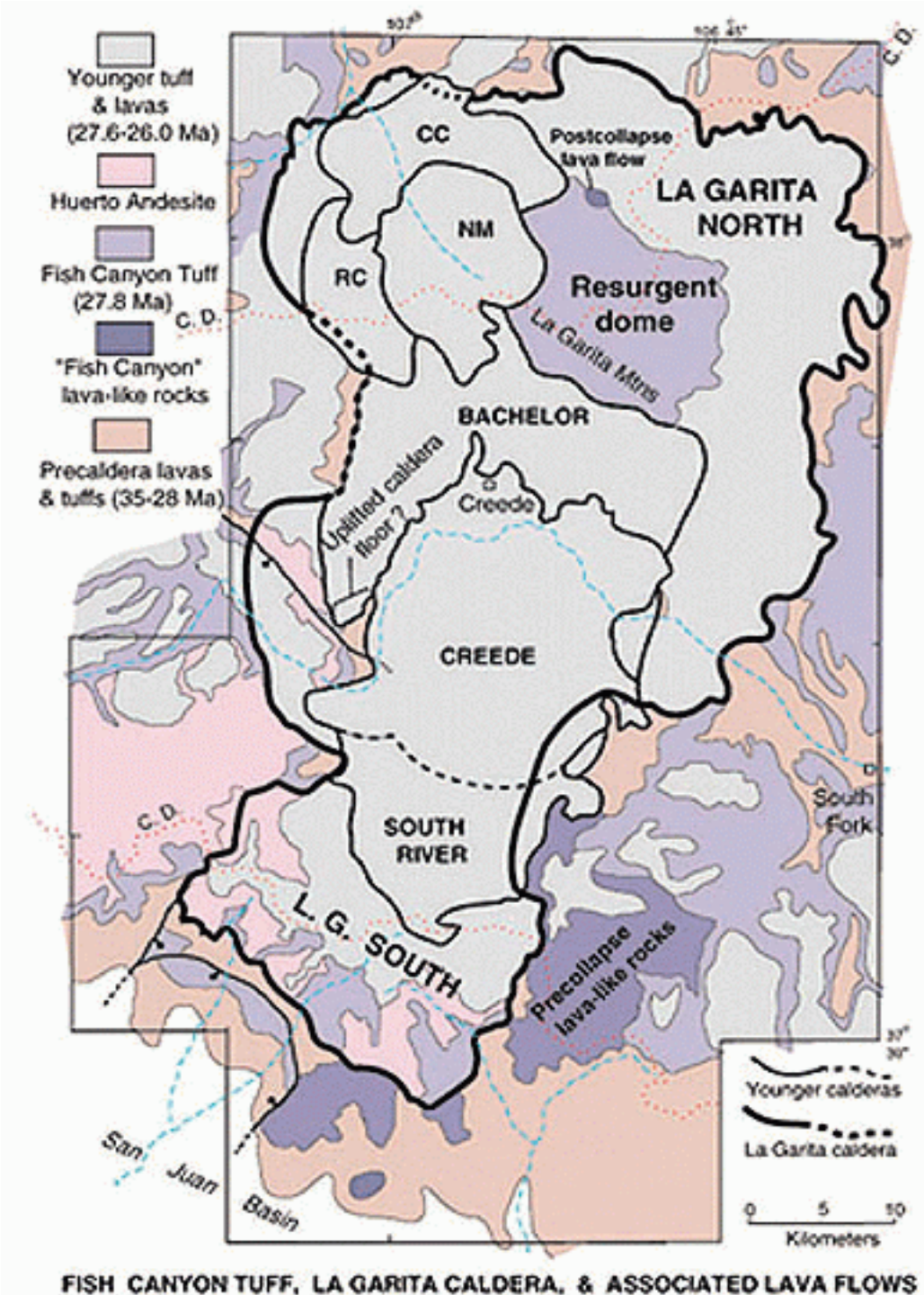
The USGS uses a scale based on the amount of material erupted by a volcano. This is called the Volcanic Explosivity Index – VEI for short.

Compare the size of the Mt. St. Helens eruption of 1980 with that of such monsters as Yellowstone and Long Valley…

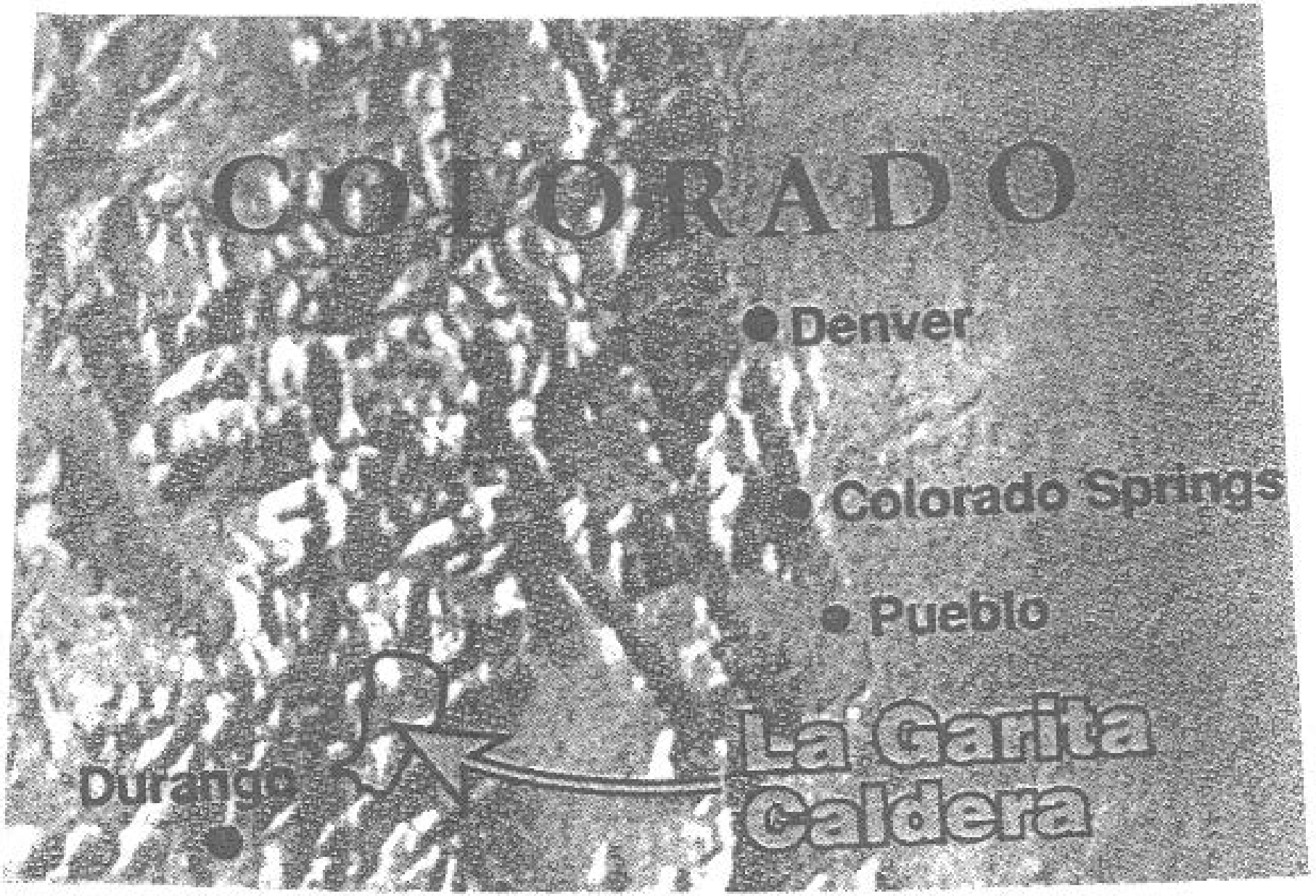
In 1995, Dr. Peter Lipman of the US Geological Survey returned to the San Juans, which he had helped map 20 years before, to try to untangle the complex geology and history of the mountains.

What he found was the largest volcanic eruption ever, far huger and more violent than even the massive Yellowstone Caldera explosion. The San Juan Volcanic Field, mapped in 1974, turned out to be the remains of one inconceivably monstrous blast.

This is now known as the La Garita Caldera eruption, and it created the San Juan Mountains we know today by utterly destroying the volcanoes that stood here before…

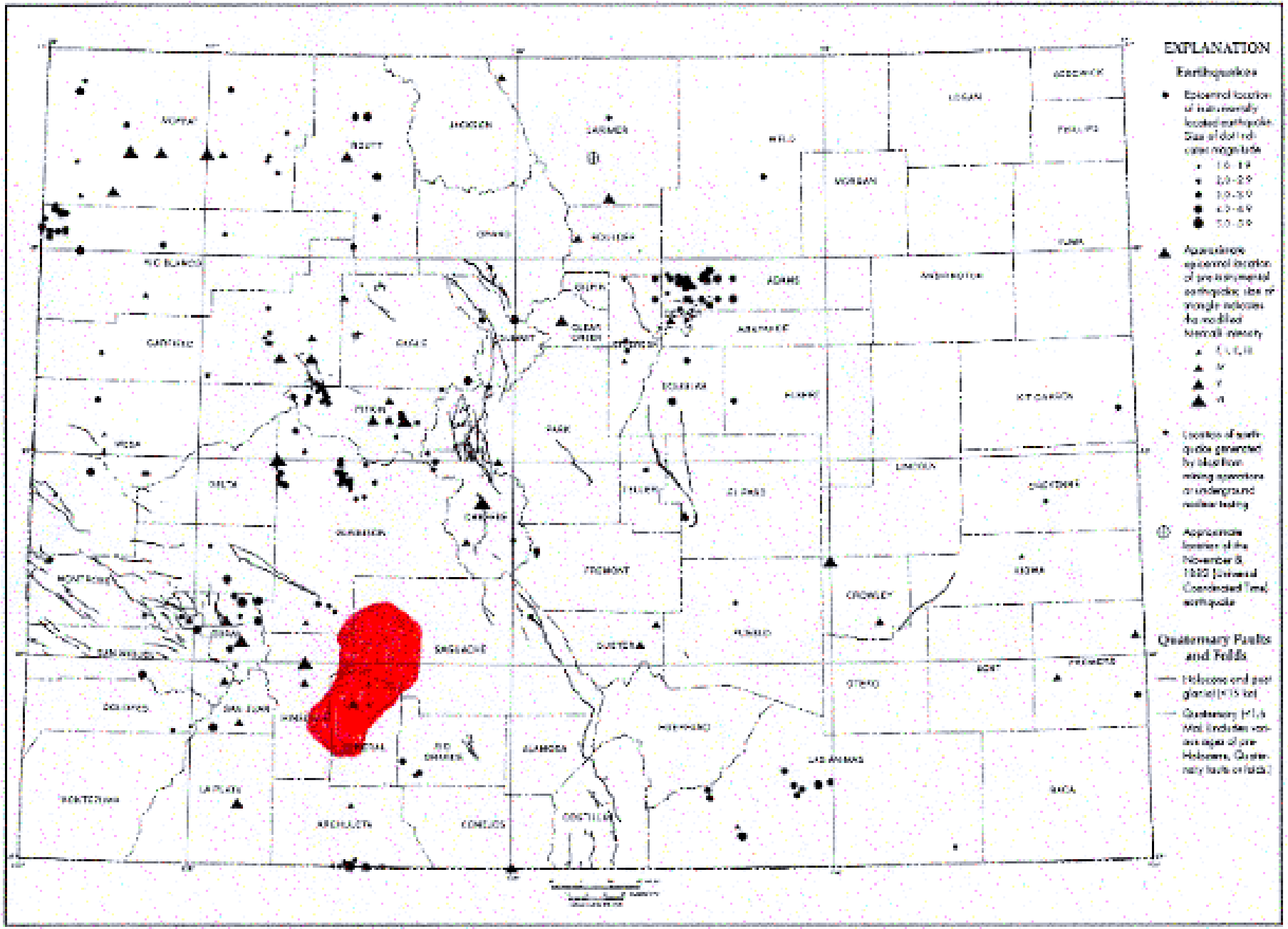


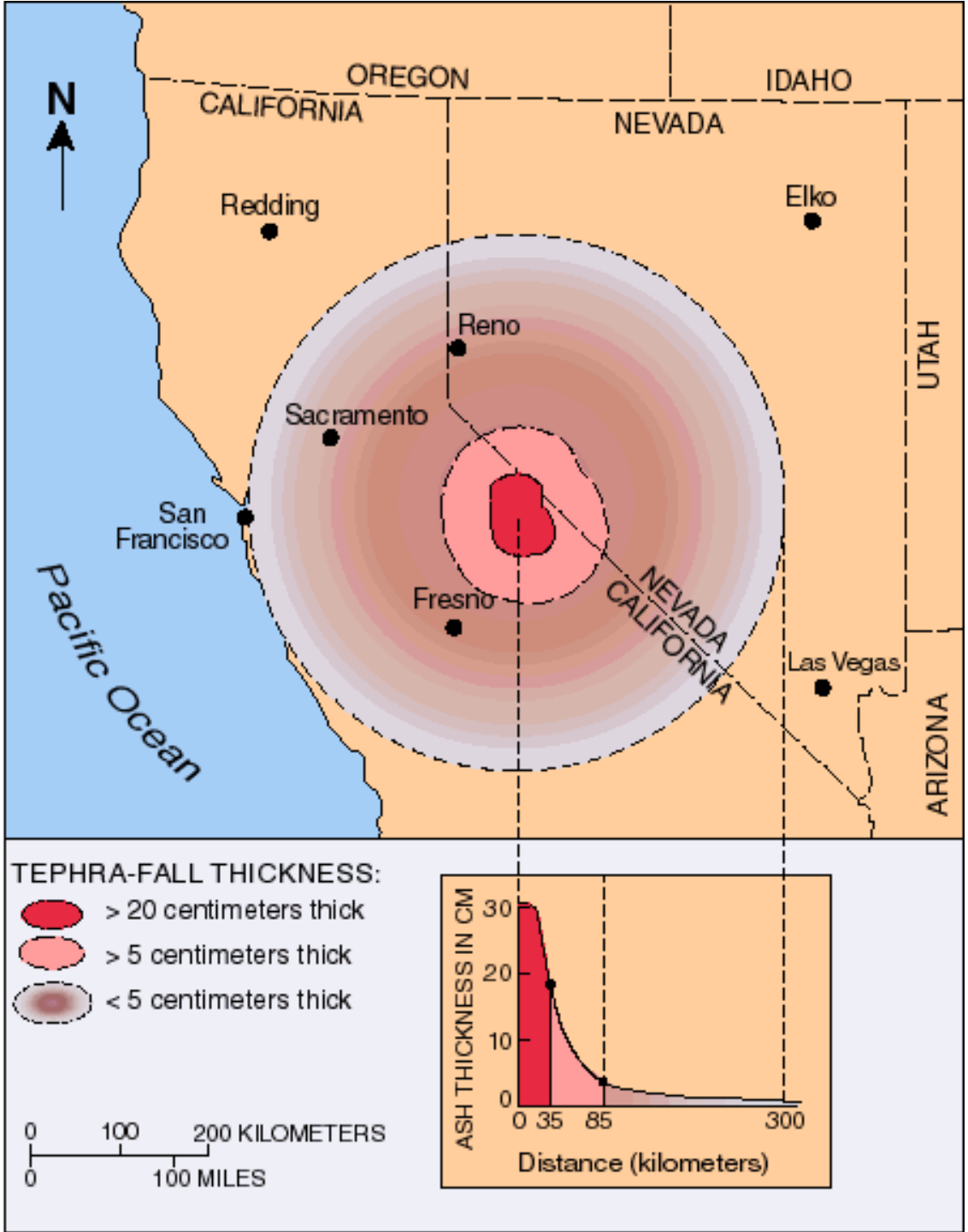
FISH CANYON TUFF, LA GARITA CALDERA, & ASSOCIATED LAVA FLOWS



La Garita blew a hole in the State of Colorado you could have seen from space…

… a glowing red wound as large as all of Mineral County…

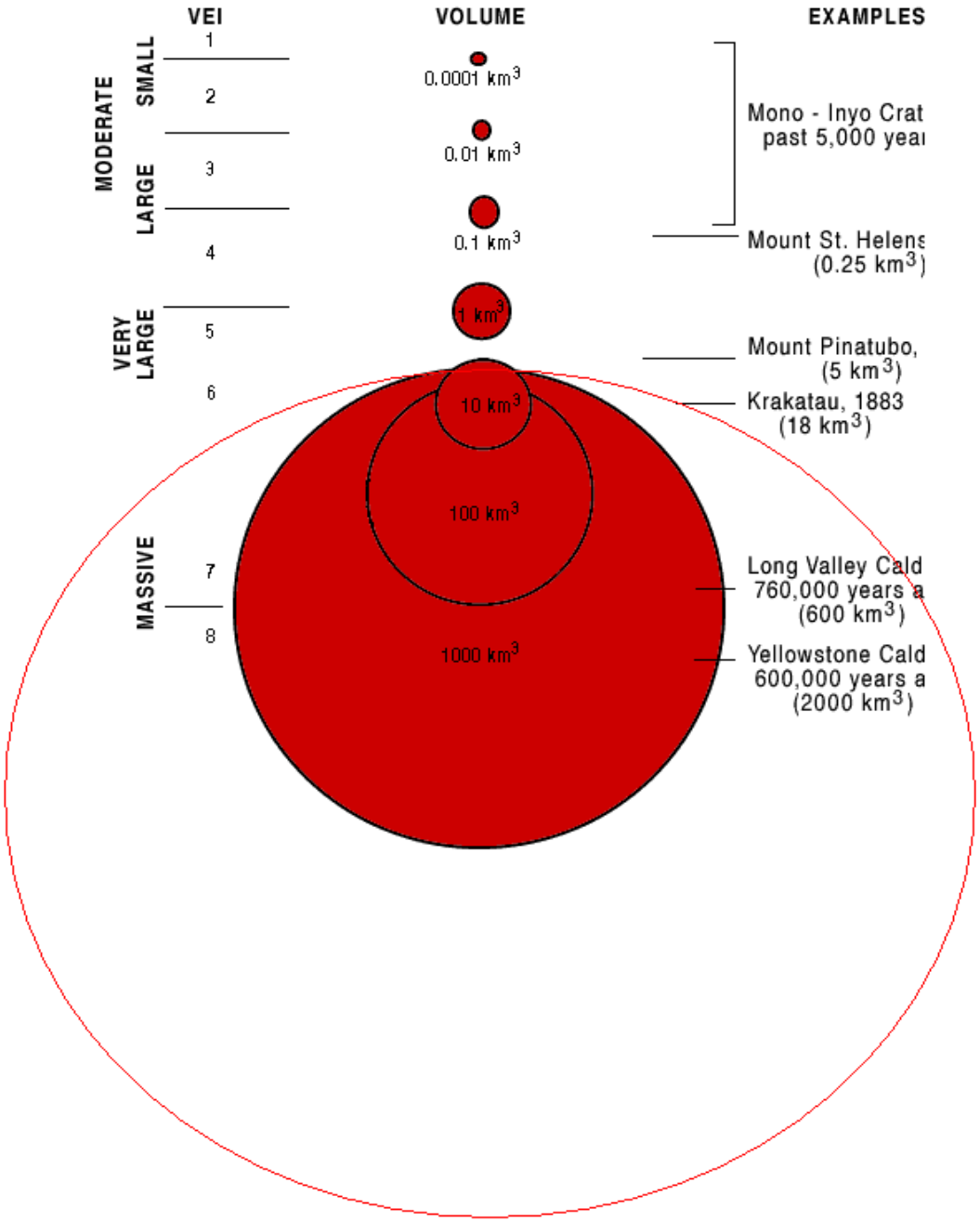




But what did this explosion ***do?*** What did it mean to the world and its life, its landscapes?

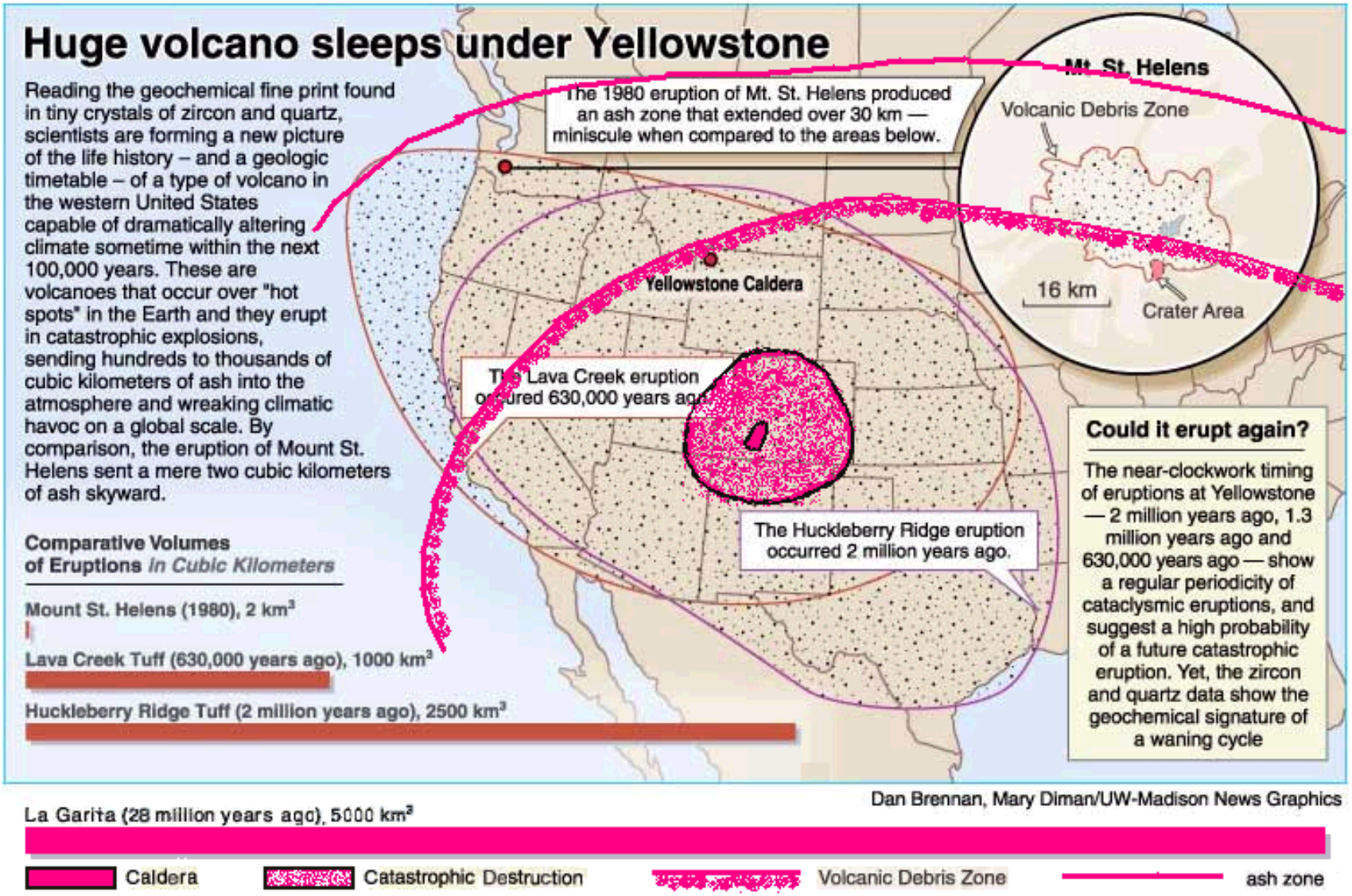
This map show the estimated ash fall from an eruption at Long Valley, based on past eruptions. The fallout zone includes Fresno, San Francisco, Sacramento, and Reno; Fresno would be hardest hit and the other cities would be seriously impacted. The ash fall from Mt. St. Helens caused billions of dollars in damage across five states, and the imaginary eruption mapped here is four times as violent as Mt. St. Helens.

The La Garita eruption was over <u>10,000 times</u> as violent as Mt. St. Helens…



La Garita blew out ***1,500 cubic miles*** of rock and ash, nearly <u>three times</u> the amount from Yellowstone…

This map compares the Yellowstone eruptions with La Garita. The red area was physically destroyed by the eruption; the outlines show the debris and ash clouds that caused ecological and climatic devastation. La Garita was a monster beyond human comprehension. If it occurred today, it would drive humanity to near extinction.



The destruction of even one volcano is humbling in its scope and power. It seems beyond imagination that there could be beauty and growth from such an event…

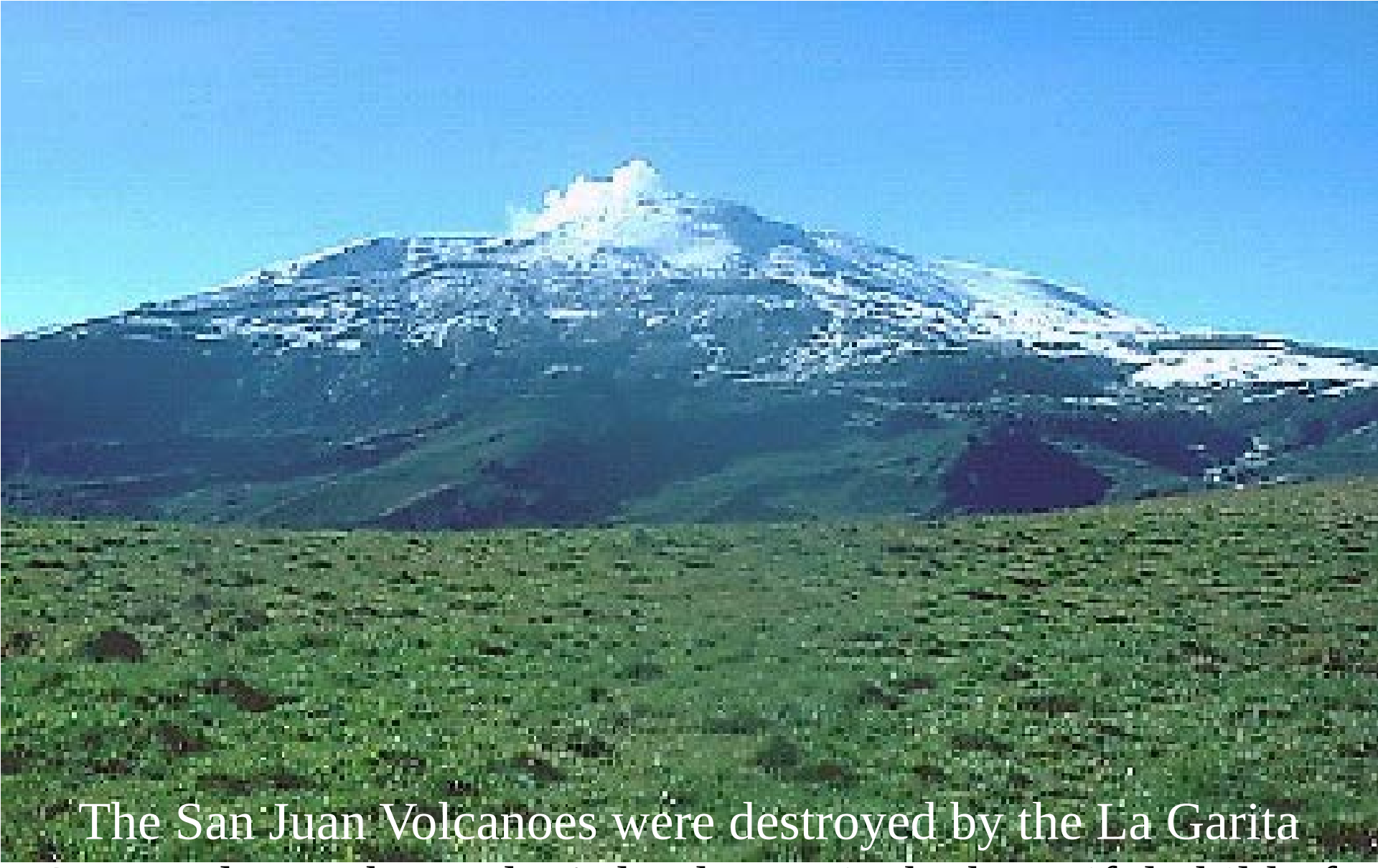
But this destroyed forest itself may have a distant future—this is how the spectacular Petrified Forest of Arizona was formed. Many times, a forest was blasted and buried by volcanic ash, only to be resurrected in stone. Minerals from the volcanic deposit replaced the wood and created the rainbow colors we see today.

So… what is the future of the San Juan Mountains?

It seems likely that the volcanic energy that drove their formation, the fracture in the crust known as the Rio Grande Rift, has died. The heat beneath the shattered volcanoes will continue to fade away; the Great Pagosa Hot Springs and other thermal springs will gradually die. Water and ice will continue to tear away at the mountains, and the rivers will carry away the wreckage. There is no Supervolcano in our **near** future…

In some 1 to 2 million years, perhaps, the glaciers may come again and finish the job, smoothing the remaining peaks to low, rounded hills; the rivers will meander sluggishly through wide, flat plains.

But nothing is certain. The inner Earth is still capable of surprises, and some day the volcanoes may return and rebuild. Distant time may again see a new range of the San Juans, with all the violent upheaval and amazing beauty that results. For the present, enjoy this snapshot of time, when the mountains tower and the rivers roar. Every day brings changes, to be appreciated all the more for their– and our– brief lifetime.



The San Juan Volcanoes were destroyed by the La Garita Supervolcano- but today's landscape is the beautiful child of that destruction.