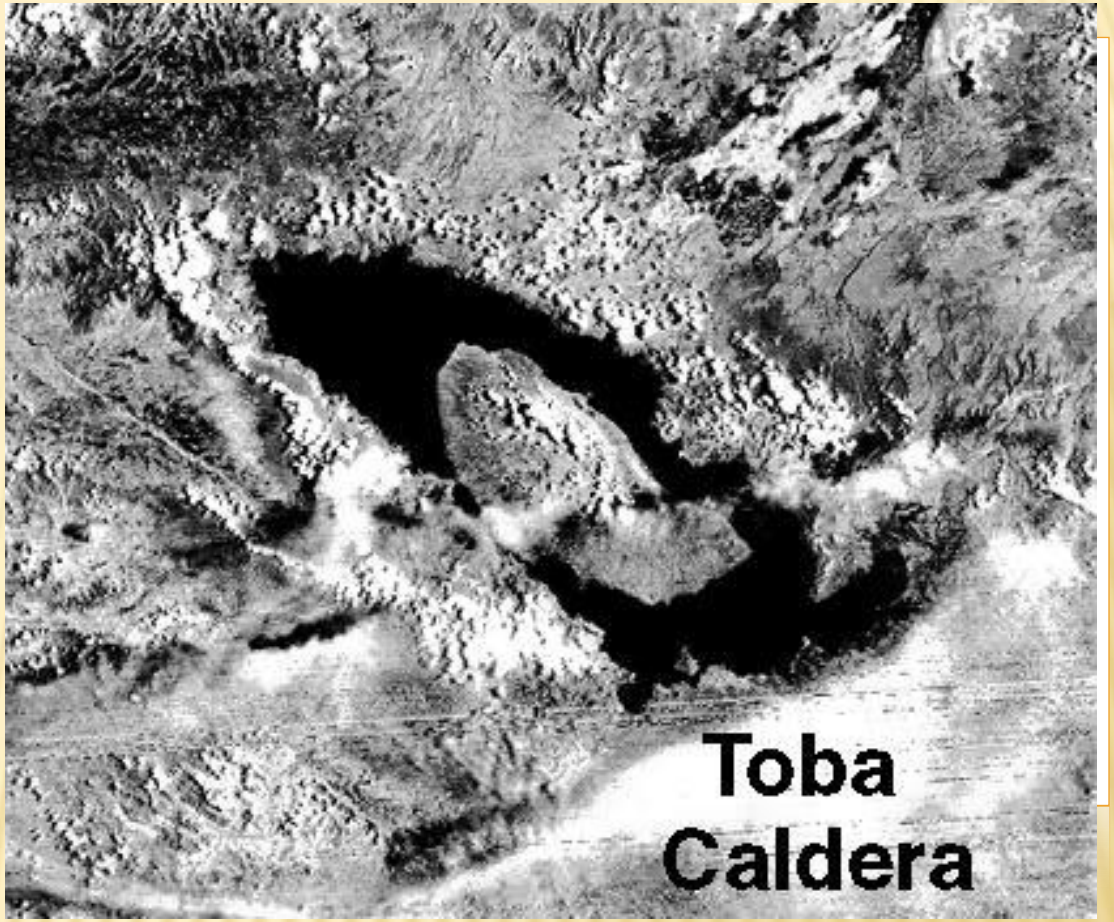


GEOLOGY AND CLIMATE

Reno, NV

June 25, 2009

GEOLOGY AND CLIMATE

- Supervolcano
- These eruptions left behind huge volcanic depressions called “calderas” and spread volcanic ash over large areas. If another large caldera-forming eruption were to occur, its effects would be worldwide. Thick ash deposits would bury vast areas, and injection of huge volumes of volcanic gases into the atmosphere could ***drastically affect global climate.***
- The term "supervolcano" has no specifically defined scientific meaning. It was used by the producers of The BBC TV show Horizion in 2000 to refer to volcanoes that have generated Earth's largest volcanic eruptions.
- As such, a supervolcano would be one that has produced an exceedingly large, catastrophic explosive eruption and a giant caldera.

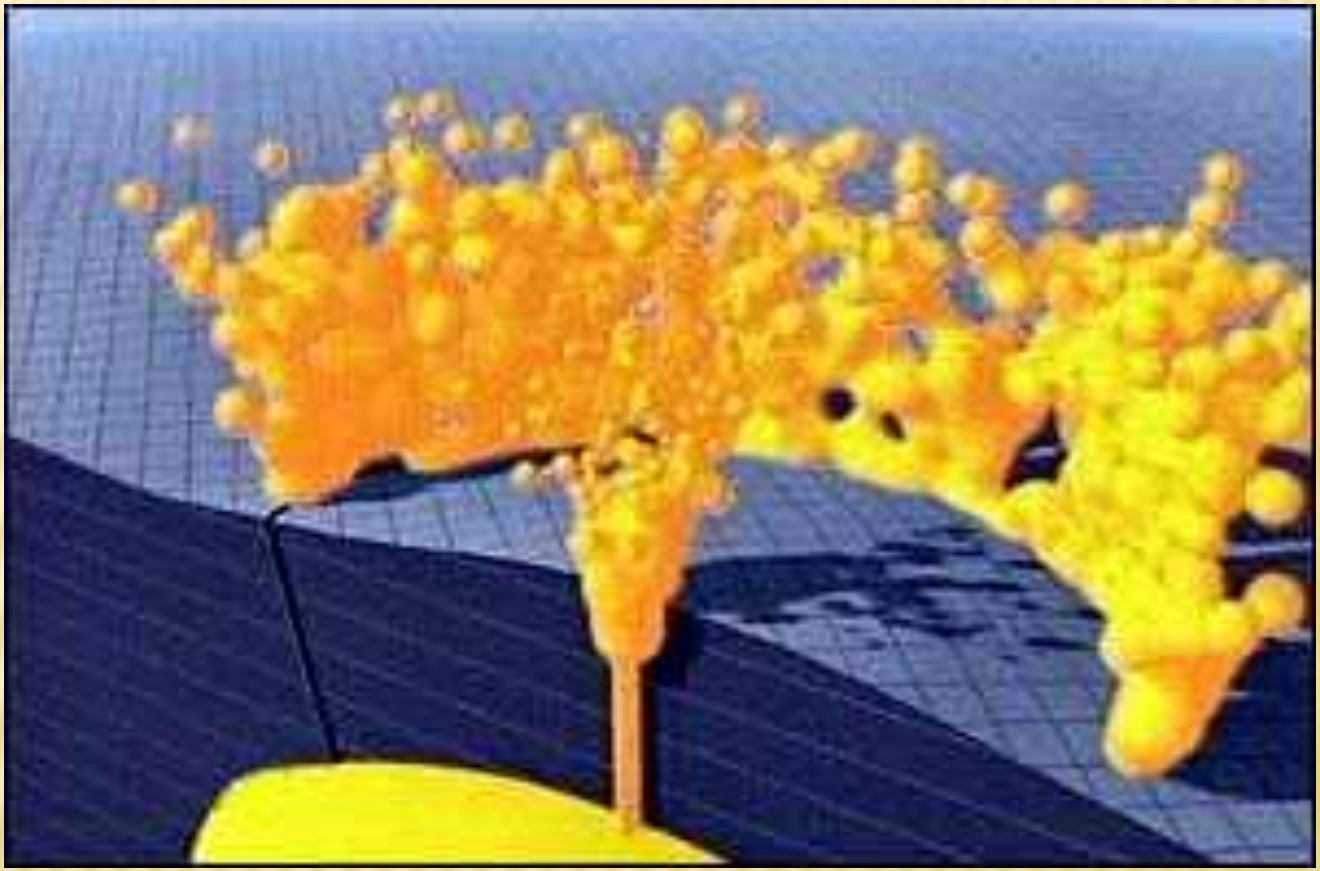
GEOLOGY AND CLIMATE

- Around the world there are several volcanic areas that can be considered "supervolcanoes“:

- Yellowstone National Park in Wyoming,
- Long Valley in eastern California,
- Valley Grande in New Mexico,
- Toba in Indonesia,
- Taupo in New Zealand,
- Aira in Japan
- The Siberian Traps in Siberia

GEOLOGY AND CLIMATE

GEOLOGY AND CLIMATE



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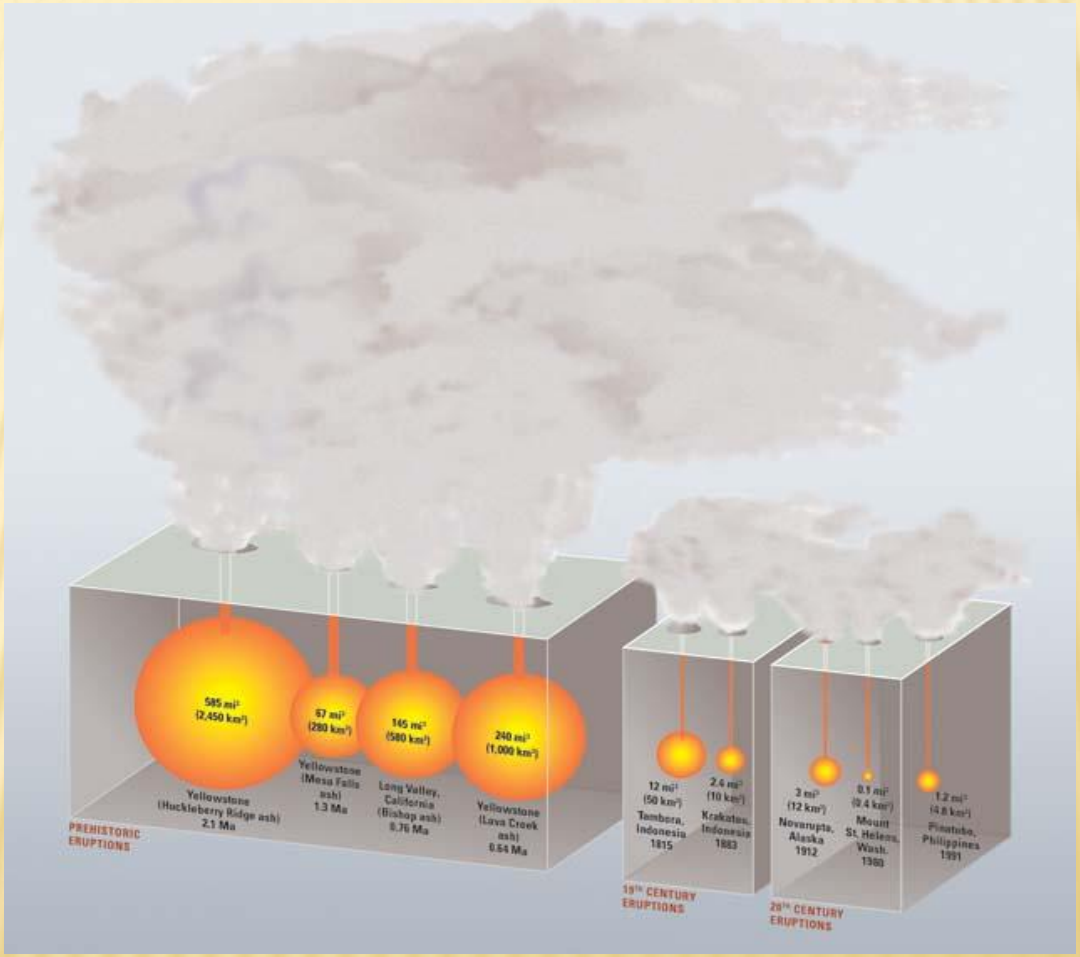
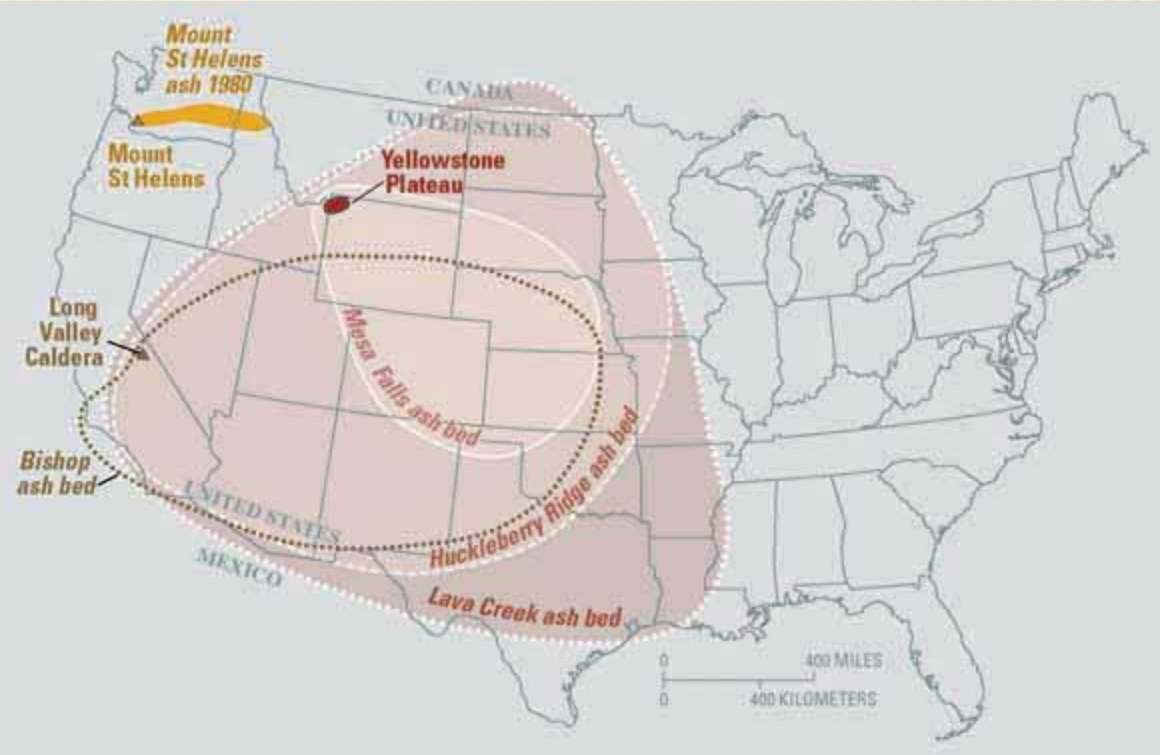


GEOLOGY AND CLIMATE

Yellowstone



GEOLOGY AND CLIMATE

- Supervolcanoes begin life when magma rises from the mantle to create a boiling reservoir in the Earth's crust. This chamber increases to an enormous size, building up colossal pressure until it finally erupts. The explosion would send ash, dust, and sulfur dioxide into the atmosphere, reflecting the sun's rays and creating a cold wave lasting several years. Crops in many areas would fail and many species of animals and plants would face extinction.
- The Yellowstone region has produced three exceedingly large volcanic eruptions in the past 2.1 million years. In each of these cataclysmic events, enormous volumes of magma erupted at the surface and into the atmosphere as mixtures of red-hot pumice, volcanic ash (small, jagged fragments of volcanic glass and rock), and gas that spread as pyroclastic (“fire-broken”) flows in all directions.

GEOLOGY AND CLIMATE

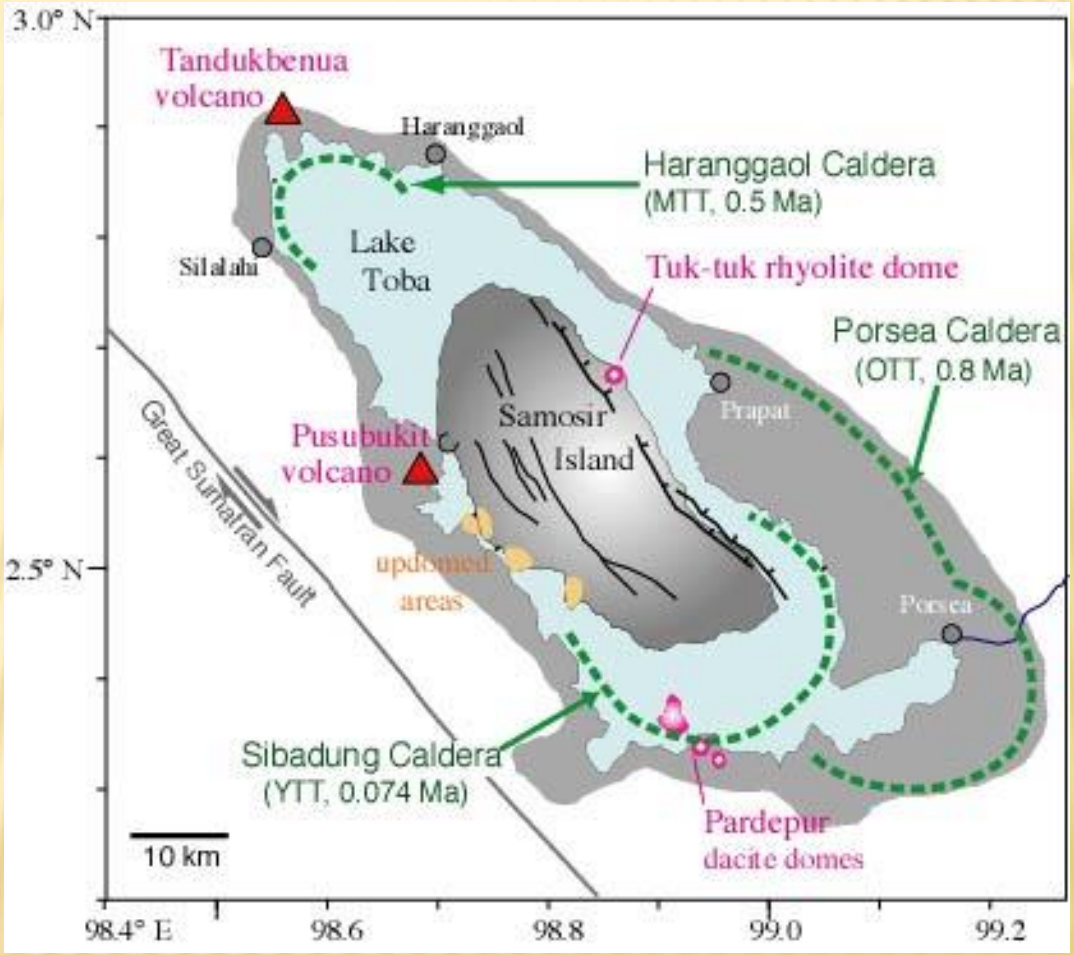
- Rapid withdrawal of such large volumes of magma from the subsurface then caused the ground to collapse, swallowing overlying mountains and creating broad cauldron-shaped volcanic depressions called “calderas.”
- The first of these caldera-forming eruptions 2.1 million years ago created a widespread volcanic deposit known as the Huckleberry Ridge Tuff, an outcrop of which can be viewed at Golden Gate, south of Mammoth Hot Springs. This titanic event, one of the five largest individual volcanic eruptions known anywhere on the Earth, formed a caldera more than 60 miles (100 km) across.
- A similar, smaller but still huge eruption occurred 1.3 million years ago. This eruption formed the Henrys Fork Caldera, located in the area of Island Park, west of Yellowstone National Park, and produced another widespread volcanic deposit called the Mesa Falls Tuff.

GEOLOGY AND CLIMATE

- The region's most recent caldera-forming eruption 640,000 years ago created the 35-mile-wide, 50-mile-long (55 by 80 km) Yellowstone Caldera. Pyroclastic flows from this eruption left thick volcanic deposits known as the Lava Creek Tuff, which can be seen in the south-facing cliffs east of Madison, where they form the north wall of the caldera. Huge volumes of volcanic ash were blasted high into the atmosphere, and deposits of this ash can still be found in places as distant from Yellowstone as Iowa, Louisiana, and California.
- If another large caldera-forming eruption were to occur at Yellowstone, its effects would be worldwide. Thick ash deposits would bury vast areas of the United States, and injection of huge volumes of volcanic gases into the atmosphere could drastically affect global climate.

GEOLOGY AND CLIMATE

Toba



GEOLOGY AND CLIMATE

- Toba caldera produced the largest eruption in the last 2 million years. The caldera is 18 x 60 miles (30 by 100 km) and has a total relief of 5,100 feet (1700 m). The caldera probably formed in stages. Large eruptions occurred 840,000, about 700,000, and 75,000 years ago. The eruption 75,000 years ago produced the Young Toba Tuff. The Young Toba Tuff was erupted from ring fractures that surround most or all of the present-day lake.
- Comparison of volumes produced by some of the greatest volcanic eruptions. The Young Toba Tuff has an estimated volume of 2,800 cubic kilometers (km) and was erupted about 74,000 years ago. The Huckleberry Ridge Tuff, erupted at Yellowstone 2.2 million years ago, has a volume of 2,500 cubic km. The Lava Creek Tuff, erupted at Yellowstone 600,000 years ago, has a volume of 1,000 cubic km.

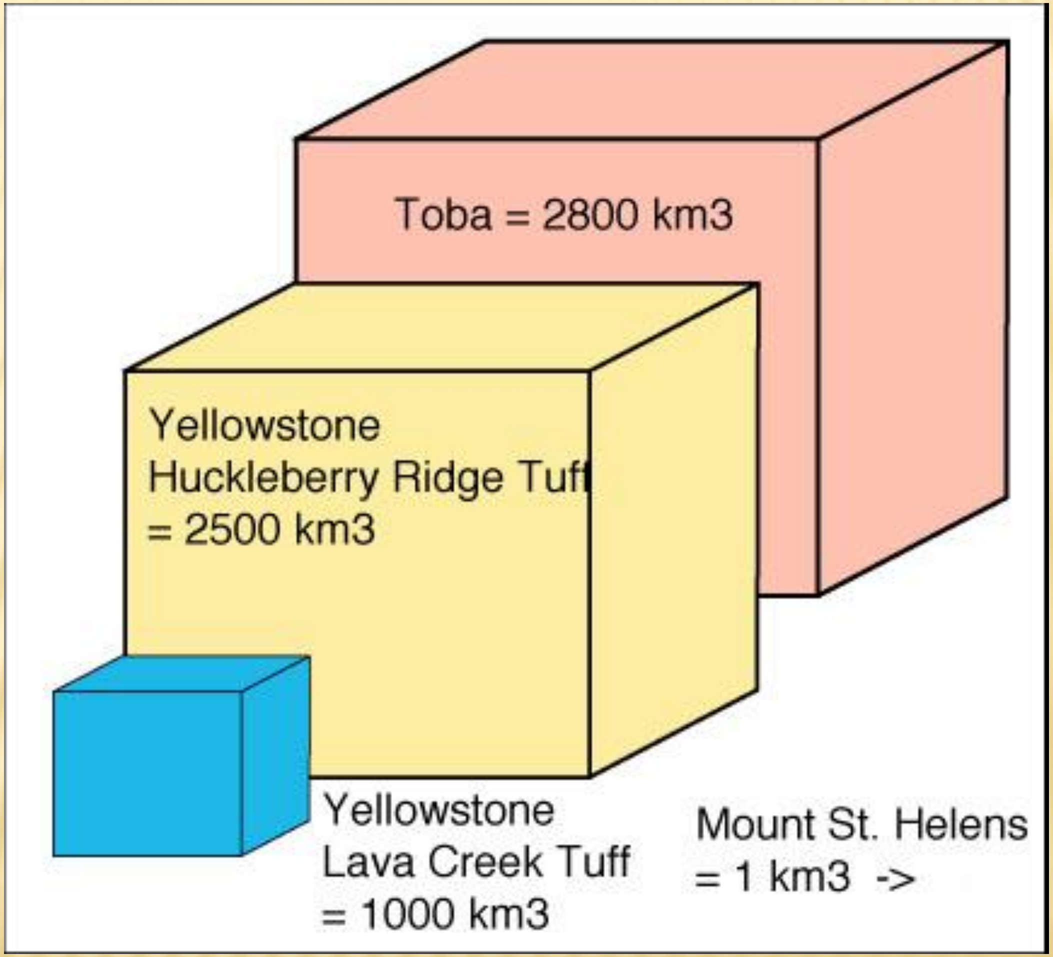
GEOLOGY AND CLIMATE

- The May 1980 eruption of Mount St. Helens produced 1 cubic km of ash. Not shown is the Fish Canyon Tuff of the San Juan Mountains of Colorado. The Fish Canyon Tuff was erupted 27.8 million years ago and has an estimated volume of 3,000 cubic km.
- The volume of the youngest eruption is estimated at 2,800 cubic km, making the eruption the largest in the Quaternary. Pyroclastic flows covered an area of at least 20,000 square km. Up to 1200 feet (400 m) of Young Toba Tuff is exposed in the walls of the caldera. On Samosir Island the tuff is more than 1800 feet (600 m) thick. Ash fall from the eruption covers an area of at least 4 million square km (about half the size on the continental United States). Ash from the eruption has been recovered from deep-sea cores taken in the Bay of Bengal and in India, roughly 300 miles (500 km) inland (1,900 miles, 3100 km from Toba).

GEOLOGY AND CLIMATE

- Rose and Chesner suggested the ash may have reached central Asia and the Middle East. Ninkovich and others (1978) estimated of the height of the eruption column to be 30 to 50 miles (50 to 80 km) for the Young Toba Tuff. Rose and Chesner, after a study of the shapes of the ash shards, concluded this estimate was too high by a factor of 5 or more.
- The pumice erupted 75,000 years ago is calc-alkalic quartz-latite to rhyolite in composition (68%-76% silica).
- About 800 km3 was ignimbrite that travelled swiftly over the ground away from the volcano destroying everything in its path, and the remaining 2,000 km3 fell as ash, with the wind blowing most of it to the west. Such a huge eruption probably lasted nearly two weeks. Very few plants, animals or humans around this part of Indonesia would have survived.

GEOLOGY AND CLIMATE



GEOLOGY AND CLIMATE

What can a volcanic eruption that occurred almost 75,000 years ago teach us about today's world of air pollution, global warming, and climate change? For starters, knowing what the massive upheaval of Indonesia's Toba supervolcano did to the planet's climate (***it might have cooled global temperatures enough to kill vegetation for years on end and perhaps hasten an ice age***) offers sobering insight into what pumping billions of tons of chemicals into the atmosphere as we're now doing could result in.

Such a powerful eruption really could send the planet's temperatures dropping quite rapidly and keep them there for quite awhile. This isn't a long time period relative to ice ages, but you can make the planet cold for many Years.

GEOLOGY AND CLIMATE

- Meteor Impact
- At the end of the Pleistocene era, woolly mammoths roamed North America along with a cast of fantastic creatures – giant sloths, saber-toothed cats, camels, lions, tapirs and the incredible teratorn, a condor with a 16-foot wingspan.
- About 12,900 years ago, these megafauna disappeared from the fossil record, as did evidence of human remains. The cause of the mass extinction and the human migration is a mystery. Now a team of scientists, including Brown University planetary geologist Peter Schultz, provides evidence that an asteroid impact likely caused the sudden climate changes that killed off the mammoths and other majestic beasts of prehistory.

GEOLOGY AND CLIMATE

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- In the Proceedings of the National Academy of Sciences, the international team lays out its theory that the mass extinctions in North America were caused by one or more extraterrestrial objects – comets or meteorites – that exploded over the Earth or slammed into it, ***triggering catastrophic climate change.***
- The scientists believe that evidence for these extraterrestrial impacts is hidden in a dark layer of dirt sometimes called a black mat. Found in more than 50 sites around North America, this puzzling slice of geological history is a mere three centimeters deep and filled with carbon, which lends the layer its dark color. This black mat has been found in archaeological digs in Canada and California, Arizona and South Carolina – even in a research site in Belgium.

GEOLOGY AND CLIMATE

- The formation of this layer dates back 12,900 years and coincides with the abrupt cooling of the Younger Dryas period, sometimes called the “Big Freeze.” This coincidence intrigued the researchers, led by Richard Firestone of Lawrence Berkeley National Laboratory, who thought that the black mat might be related to the mass extinctions.
- Directly beneath the black mat, researchers found high concentrations of magnetic grains containing iridium, charcoal, soot, carbon spherules, glass-like carbon containing nanodiamonds and fullerenes packed with extraterrestrial helium – all of which are evidence for an extraterrestrial impact and the raging wildfires that might have followed.