The Yellowstone Caldera: Possible Effects of a Supervolcano Eruption

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Unfounded Doomsday Scenarios

• There is little scientific evidence to prove that the Yellowstone Caldera:
  – Is the Armageddon
  – Is definitely going to erupt sometime soon
    • In our lifetimes or the next generations’ lifetimes
  – Will kill everything on Earth
  – Will block out sunlight completely
  – Will cause “nuclear winter”
• Scare tactics that lead to emotional response from those with little scientific background
  – Good for Hollywood, bad for real life scenarios
• So what do actual scientific experts say?
• It is important to get accurate scientific information
Why care about the science of geology?

• Not just rocks:
  – “the science that deals with the dynamics and physical history of the earth, the rocks of which it is composed, and the physical, chemical, and biological changes that the earth has undergone or is undergoing”

• Helps to better understand the earth and how it has changed over time

• Allows for better prediction of earthquakes and volcanoes
  – Seismologists and volcanologists part of geology
What is a caldera?

• Volcano with a depression many times wider than its vent
  – Caused by emptying large, underlying magma (molten rock) chamber(s)
What is a Supervolcano?

• Long lived
  – active for millions of years
• Longer dormant time= Larger eruptions
• Generally an eruption of more than 100-200 km$^3$ of magma
  – Mt. St. Helens (1980) was 0.5-2 km$^3$
  – Krakatoa, Indonesia (1883) and Mt. Pinatubo, Philippines (1991) were 25 km$^3$
    • Lowered average global temperatures by 1.2° C (~2.2°F) and .6° C, respectively
  – Last 3 major eruptions of Yellowstone Caldera have ranged from 240 to 2,500 km$^3$
History of Yellowstone Caldera

Track of the Yellowstone Hot Spot

Plate Motion

Regional Basaltic Lavas

Yellowstone Caldera

Hot Spot Track

12.5

10.3

6.5

2.0-0.6
Background

• Caldera is currently about 1,440 mi.\(^2\) in size
• Roughly the size of Rhode Island
• Erupted ~2, ~1.3, and ~.63 mya
  – ~700,000 years between eruptions
    • 640,000 years since last major eruption
    • Due relatively soon on a geologic time scale (~6 billion years old)
      – 60,000 years represents 0.0001% of Earth history
YouTube Video

• Video
• From Naked Science

• http://www.youtube.com/watch?v=zh9zVXUv-Fs
Effects of an Eruption
Ash Clouds

• Blanket of ash prevents sunlight from reaching earth
  – Causes cooler temperatures
• Atmospheric disruption could continue for decades
  – Would lead to famine in places

Mt. St. Helens ash cloud which is magnitudes of order smaller than Yellowstone
Ash Clouds and their Composition

• Chemical effects of sulfur gas & sulfur aerosols
  – Sulfur gas to sulfuric acid to ammonium sulfate
    • Sulfuric acid is responsible for acid rain
    • Ammonium sulfate
      – White solid aerosol (liquid or solid particles suspended in a gas)
      – Reflects sunlight back into space = cooling effect

• Takes about a year to reach stratosphere (layer 2\textsuperscript{nd} closest to surface, which also contains ozone layer) but can stay in atmosphere for several years
Climate Change Impacts

- Scattering of incoming solar radiation leads to surface cooling and counteracts greenhouse effect
- Based on Michael Rampino’s (geologist and biologist at NYU) study of the Toba (Sumatra) supervolcano eruption 74,000 years ago, these effects could be seen as a result of Yellowstone:
  - Climate could cool for decades
    - More ash= longer period of cooling
    - Agricultural land in higher latitudes could become useless for period of time
      - High latitudes could cool roughly 21°F
      - ~75% of plant species in the Northern Hemisphere could die off
- Yellowstone’s largest eruption could be similar in size
Cooling Effects

• Mt. Pinatubo recorded cooling
  – 25 km$^3$ versus 240 to 2500 km$^3$ at Yellowstone
Eruption Effects (cont.)

- According to Lowenstein:
  - Could destroy all living beings and infrastructure over tens of thousands of sq. km
- Hard to actually determine since they are rare and there is little first-hand experience
  - Even if there is one to study, it is still hard to compare small eruptions to large due to the lack of a large enough sample size for comparison
Actual Chances of Eruption

- There will be most likely be a supervolcano eruption sometime in the next 100,000 years
- Geologic time scale spans the entire history of Earth
  - So, when geologists use the word soon, it is in a different context than most people can comprehend
  - Hard to understand 6 billion years
- Chances in our lifetime are slim
  - ~60,000 yrs until we reach average eruption
    - 0.0001% of Earth history
  - It’s like 40 minutes in the entire 77.8 year lifespan of a human being
  - So, as a general audience, it is important to be wary of doomsday scenarios without legitimate proof
References


