Is there a link between explosive volcanism and the Earth’s climate? with Suzanne Straub

Michael J. Passow
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First, a few light-hearted looks at how many people view volcanoes.
Looks like your sacrifice fly wasn't enough to appease the gods!

"The gods aren't angry, Tara. They're just hurt and disappointed."
There are many dark humor volcano cartoons
One does not simply
survive a supermassive volcanic eruption
Not everyone who goes into a volcano stays in

• Woman falls into volcano vent on Oregon's Mount Hood: 'I was terrified' - ABC News

• Woman falls into volcano vent on Oregon's Mount Hood: 'I was terrified’

• Now, let’s look at the science behind today’s presentation.
• All volcanoes are dangerous, but some are more so. Volcanologists describe the power and effects of an eruption by the Volcano Explosivity Scale (or similar terms).
Wah Wah Springs
30 Million years ago
>5500 cu km (VEI 6)

Yellowstone
640,000 years ago
1000 cu km (VEI 8)

Long Valley Caldera
760,000 years ago
580 cu km (VEI 7)

Toba
74,000 years ago
2800 cu km (VEI 8)

Novarupta
13 cu km
1912 (VEI 6)

Pinatubo
5 cu km
1991 (VEI 5)

Krakatau
20 cu km
1883 (VEI 6)

Crater Lake
7,800 Years ago
150 cu km (VEI 7)
<table>
<thead>
<tr>
<th>VEI</th>
<th>Eruptive Style</th>
<th>Magnitude</th>
<th>Distance</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 0.001 km³</td>
<td>Hawaiian / Strombolian</td>
<td>gentle</td>
<td>100–1000 m</td>
<td>daily</td>
<td>minor</td>
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<tr>
<td>2</td>
<td>&gt; 0.001 km³</td>
<td>Strombolian / Vulcanian</td>
<td>explosive</td>
<td>1–5 km</td>
<td>weekly</td>
<td>moderate</td>
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<td>3</td>
<td>&gt; 0.01 km³</td>
<td>Vulcanian / Peleán</td>
<td>severe</td>
<td>3–15 km</td>
<td>few months</td>
<td>substantial</td>
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<tr>
<td>4</td>
<td>&gt; 0.1 km³</td>
<td>Peleán / Plinian</td>
<td>catastrophic</td>
<td>10–25 km</td>
<td>≥ 1 yr</td>
<td>substantial</td>
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<tr>
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<td>&gt; 1 km³</td>
<td>Plinian</td>
<td>paroxysmal</td>
<td>20–35 km</td>
<td>≥ 10 yrs</td>
<td>substantial</td>
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<td>6</td>
<td>&gt; 10 km³</td>
<td>Plinian / Ultra-Plinian</td>
<td>colossal</td>
<td>&gt; 30 km</td>
<td>≥ 100 yrs</td>
<td>substantial</td>
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<td>&gt; 100 km³</td>
<td>Ultra-Plinian</td>
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<td>&gt; 40 km</td>
<td>≥ 1000 yrs</td>
<td>substantial</td>
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<td>VEI</td>
<td>Erupted tephra volume</td>
<td>Examples</td>
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<tr>
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<td>Merapi, Indonesia 2010</td>
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<tr>
<td>3</td>
<td>1 km³</td>
<td>Mount St Helens May 18, 1980</td>
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<td>4</td>
<td>10 km³</td>
<td>Pinatubo 1991 Krakatau 1883</td>
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<tr>
<td>5</td>
<td>100 km³</td>
<td>Tambora 1815 Mazama 7700 years ago</td>
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<tr>
<td>6</td>
<td>1,000 km³</td>
<td>Long Valley Caldera, CA 760,000 years ago</td>
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<tr>
<td>7</td>
<td></td>
<td>Yellowstone Caldera 600,000 years ago</td>
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</table>
One result of the “year without Summer” (1816) after Tambora
Milankovitch Cycles

- Precession: 19-24,000 years
- Eccentricity: 100,000 years, 413,000 years, 41,000 years
- Tilt: 21.5°-24.5°, currently 23.5°

Milankovitch Cycle

Eccentricity: Earth encounters more variation in the energy that it receives from the sun when Earth’s orbit is elongated than it does when Earth’s orbit is more circular.

Tilt: The tilt of Earth’s axis varies between 22.2° and 24.5°. The greater the tilt angle is, the more solar energy the poles receive.

Precession: A gradual change, or “wobble”, in the orientation of Earth’s axis affects the relationship between Earth’s tilt and eccentricity.

Graph:
- $e$ (deg)
- $\sin(w)$
- $Q^{\text{day}}$ (W m$^{-2}$)
- $\Delta T_s$ (K)

- benthic forams
- Vostok ice core

kiloyears A.D.
Scientific Ocean Drilling

- In the interest of time, we won’t view this entire video, but go on to the [https://earth2class.org/site](https://earth2class.org/site) at your convenience and watch
- [https://www.youtube.com/watch?v=0nydKlpZdIU](https://www.youtube.com/watch?v=0nydKlpZdIU)
- [http://www-odp.tamu.edu/publications/citations/cite145.html](http://www-odp.tamu.edu/publications/citations/cite145.html)
Global Proxies

- Sea level
- Ocean sediment
- Ice cores
  - Layers (varves) in ice cores
  - Gases in ice cores
  - Stable Isotopes: O-16 to O-18 ratio in ice cores
  - Radiometric Isotopes: Carbon dating of sediment in the ice cores or glacial deposits
Proxies

- Corals*
- Tree rings*
- Pollen*
- Fossils*
- Sea level
- Lake ice duration*
- Ocean sediments
- Ice Cores

*indicative more of local climate change than global climate change
Glaciers form as layers of snow accumulate on top of each other. Each layer of snow is different in chemistry and texture, summer snow differing from winter snow. Over time, the buried snow compresses under the weight of the snow above it, forming ice. Particulates and dissolved chemicals that were captured by the falling snow become a part of the ice, as do bubbles of trapped air. Layers of ice accumulate over seasons and years, creating a record of the climate conditions at the time of formation, including snow accumulation, local temperature, the chemical composition of the atmosphere including greenhouse gas concentrations, volcanic activity, and solar activity.

[https://icecores.org/about-ice-cores](https://icecores.org/about-ice-cores)
ABOUT THE SHIP

JOIDES RESOLUTION
is a research vessel 143 meters long

1. DERRICK
Is 62 meters above the water line

2. CATWALK
Where the cores are sent after drilling.

3. DRILL STRING
Can reach depths of up to 8,235 meters, that's about six miles beneath the ocean surface!
Figure 3. Example of core description form ("barrel sheet") used for describing sediments and sedimentary rocks.

has been specified in terms of meters below sea level (mbsl) and

Logic Description" column of the barrel sheet. In an interval comprisi-
Figure 4. Sediment lithology/lithologic component symbols used in the “Graphic Lithology” column on the core description form shown in Figure 3.
Survey Question 5 - Freq. of incorporation

1. Consistent across cohorts
   - All reported Specific Times or Often or Possible, none reported Rarely or Not at All
   - Other - informal education (museums, media) (esp. '10)

2. Key Differences
   - No sign. differences in general totals
   - '10 - less than a year between end of program & survey again, different types of participants

3. Short-based vs. Shipboard
   - No sign. diffs. wrt survey results, but discussion about "total immersion" vs. '9-5-hotel'
   - Themes of each SOR may influence what is taught
   - ? about % of curriculum influenced, amt. of time
   - ? amt. of inclusion in middle, high, college
One or two last ones

“FRANKLY, I CAN’T WAIT UNTIL I EVOLVE INTO A BIRD...”

How can you tell two geologists are in love?