

200th anniversary of Tambora eruption a reminder of volcanic perils

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The summit caldera of Tambora, which is about 6 kilometers wide and 7 kilometers long and more than 1 kilometer deep, was created by the 1815 eruption. Gray eruptive products form the top of the caldera wall (foreground) and appear to be 200-year-old pyroclastic flow or late surge deposits. On the floor of the caldera is an ephemeral lake (center) and a small cone from a post-1815 eruption (lower right of lake). Credit: Katie Preece



The 2010 eruption of the Icelandic volcano Eyjafjallajökull grounded thousands of air flights and spread ash over much of western Europe, yet it was puny compared to the eruption 200 years ago of Tambora, a volcano that probably killed more than 60,000 people in what is now Indonesia and turned summer into winter over much of the Northern Hemisphere.

"Because Tambora ejected sulfurous gas that generated sulfate aerosols in the atmosphere, which block sunlight, the eruption created a 'year without a summer,' leading to food shortages—people were eating cats and rats—and very general hardship throughout Europe and eastern North America," said Stephen Self, an adjunct professor of earth and planetary science at the University of California, Berkeley, and an expert on volcanoes, in particular supervolcano eruptions 10 times larger than Tambora.

Tambora, which blew its top on April 10 and 11, 1815, is an example of the destruction volcanoes can wreak, he said, possibly made worse today by denser populations and our reliance on air transport. Self will deliver an invited talk April 7 at the opening of a four-day conference on Tambora in Bern, Switzerland, and will publish a commentary on the risk posed by volcanic eruptions in the April issue of the journal Nature Geoscience.

"An eruption of that size today would certainly have major effects on air traffic as well as atmospheric circulation around the globe, so we would like to know when the next big one is coming," Self said. "But we can't predict that if we don't know the size of past eruptions and when they took place."

That information is simply unavailable even for big, Tambora-like eruptions over the past thousand years, he said.



"Even in a country with well-studied volcanoes, like Japan, at least 40 percent of the big eruptions are missing from the record," he said. "And if you look back beyond the past 1,000 years, to 3,000 or 4,000 years ago, the record gets worse and worse. We know there are big eruptions hiding from the record that we don't know about."

Many explosive eruptions send sulfate molecules, primarily sulfuric acid, around the globe that fall as acidic snow on glaciers and ice caps, leaving traces that can be seen in ice cores from Greenland and elsewhere. Self recently suggested that one mysterious ice-core sulfate peak, dating from 1452, resulted from an eruption off the island of Vanuatu in the Pacific Ocean that left behind a submerged hole, or caldera, remembered only through local legend.

"It is high time for a systematic exploration of all the available eruption archives—ice cores, ocean sediments, remotely sensed caldera volumes and geochronological analysis of eruption deposits—so that we have a better chance to understand potential future hazards," he wrote in *Nature Geosciences* with coauthor Ralf Gertisser of Keele University in the United Kingdom.

Volcano risk study urged

In January, the Global Volcano Model and the International Association of Volcanology and Chemistry of the Earth's Interior issued a report on the hazards and risks of eruptions around the world. The groups noted a lack of information on the frequency and size of eruptions like Tambora, which makes it hard to estimate the danger to life and property from historically active but not currently erupting volcanoes.

Not surprisingly, the report identified Indonesia as the most dangerous place for volcanoes. Tambora, located on the island of Sumbawa in Indonesia, was the largest and deadliest known eruption of the last 750



years; a possibly larger explosion occurred on the nearby island of Lombok in 1257. Krakatau, on the western end of the Indonesian archipelago, is perhaps the best-known of the Indonesian volcanoes. Its 1883 eruption killed more than 34,000 people and was the second deadliest after Tambora. Tambora erupted three times the amount of ash and lava as Krakatau, Self said.

Recently, scientists have proposed that the eruption of Toba on the island of Sumatra 74,000 years ago was the most destructive supereruption ever recorded: the explosion created a 100 by 60 kilometer caldera now occupied by Lake Toba, and spread ash as far away as the Himalayas 3,000 kilometers to the northwest.

According to the January report, 90 percent of the volcano risk worldwide is in the five nations of Indonesia, Philippines, Japan, Mexico and Ethiopia.

Self has spent much of his career visiting the calderas of major <u>volcanic</u> <u>eruptions</u> and collecting samples of ash and lava in order to determine when and how much they erupted in the past. In 1979, he was the first modern-day scientist to visit Tambora, a shield volcano somewhat like those in Hawaii, to collect rock for analysis. He later estimated that when it exploded in 1815, it blew out 30 to 50 cubic kilometers of material, a major change from the volcano's earlier behavior.

Sulfur gas ascended into the stratosphere, spawning sulfate aerosol particles that were carried around the world, blocking sunlight for more than a year. This is the best-known example of volcano-induced global cooling, Self said. Some estimate that the global average temperature dropped more than 1 degree Celsius (1.4 degrees Fahrenheit) as a result, causing crop failures in Asia as well as Europe and North America.

For comparison, Mount St. Helens in Washington erupted about 1 cubic



kilometer of material in 1980, while Pinatubo's output in 1991 was about 5 cubic kilometers.

California's smoking Long Valley caldera

Mainland North America has its own worrisome volcanoes. Crater Lake was created by an eruption of Tambora's size 7,700 years ago, while the area around Yellowstone National Park was ground zero for a long series of super-eruptions, the most recent about 640,000 years ago, that blanketed much of the North American continent with ash. Long Valley caldera east of California's Sierra Nevada, within which sits the town of Mammoth, is considered an active supervolcano, though it's one and only huge eruption was 760,000 years ago.

Smaller volcanoes, such as Mount Rainier and Mount Hood in Washington and Oregon, respectively, are still considered active, while California's Mount Lassen erupted just 100 years ago.

"We can't stop an eruption, but we can prepare to adapt to the immediate impact of ash on air traffic and the delayed effect of sulfate aerosols on crops and vegetation," Self said. Aside from the immediate, ground-level danger from ash flows, lava and hot gas to people living around an erupting volcano, ash thrown into the air, and sulfate aerosols, can pit airplane windows and damage jet engines, while both can cause respiratory problems downwind.

Self said that the 1816 "year without a summer" was not immediately associated with the Mount Tambora eruption because the western world didn't learn of its explosion until months later, when reports finally made their way by ship from the Dutch East Indies. Krakatau's fame comes as much from the existence of a new device, the telegraph, which immediately carried news of the eruption around the world in 1883, as from its size and global impact.



The Tambora <u>eruption</u> may have had one famous outcome. Had it not been for the cold, wet weather it brought to Europe, Mary and Percy Shelley and Lord Byron might not have spent the summer of 1816 telling ghost stories around a log fire in a rented house on Lake Geneva, and Mary Shelley might never have turned the best of those tales into a famous book, Frankenstein.

"Frankenstein was wrought from the year without a summer, all due to this volcano that nobody's ever heard of," Self said.

Provided by University of California - Berkeley

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