

b5 Volcanism and climate < Pinatubo, Krakatau, Mount Tambora >

The bright sun was extinguish'd ... and the icy earth / Swung blind.

—Lord Byron *Darkness*, written 16 months after the April 1815 explosion of Tambora.¹

Albedo is the fraction of reflected to incident radiation (presently ~0.29 globally, while without clouds it is ~0.15).² Earth's seasonal temperature variations are due to Sun's incident radiations and albedo (which reflective atmospheric dust, cloud cover, and snow increases, and leafy-vegetation cover that absorbs all but the green rays decreases). A quest is to know causes and involved feedback-mechanisms for long-term (decade, century, millennial, and geological) climatic variations.

Explosive Andean-type volcanos (stratovolcanoes) can erupt tremendous amounts of smothering ash, suffocating CO₂, and choking SO₂. The latter aerosol injected along with water by Plinian eruption columns into the stratosphere, nucleates sunlight-reflective cubic³ ice crystals. These are too tiny to settle effectively and prevailing winds carry them and sunlight-reflective volcanic ash for years round the globe. By contrast, wind-lofted ground dust and industrial smoke-stack emissions circulate only in the troposphere, and from it they are quickly washed out by rain. CO₂, which is ever present in the atmosphere (and lessens Earth's albedo by 0.01 presently), dissolves in rainwater and makes it slightly acidic (pH 5.6). Downwind of volcanic or industrial emissions of SO₂ and NO_x, lower-than-normal pH "acid rain" can degrade ecosystems (mostly by killing plants).

The 1991 Plinian eruption of Mt. Pinatubo injected into the stratosphere some 200 million tons of SO₂. The effect of this was to cool world climates measurably (global albedo increased ~0.007) for two years.⁴

Temperatures dropped about 2°C worldwide following the 1883 Plinian eruption of Krakatau (Krakatoa) in the Sunda straits between Java and Sumatra, Indonesia. Soon after this eruption, it had been recorded at the Seychelles, mid-Indian ocean, that, the sky "had a very threatening and strange appearance of a deep purplish colour which, with the disturbances of the seawater, caused much fear and excitement" and the scare opened for militant Islamic proselytizers the door to Indonesia.⁴ The eruption which ejected 10 km³ of rock and associated stratospheric dust, resulted in spectacular sunsets for several years worldwide (as so struck artist Edvard Munch, in Norway) and a "once in a blue Moon" so seen Moon from China.⁵

The 1815 Plinian eruption of Mt. Tambora killed 50,000 of its island people directly and exploded away that once highest mountain of the Indonesian volcanic archipelago. To this greatest concatenation in historical time was causally linked one of the coldest summers on record in the Northern Hemisphere. In Europe, 1816, "The Year without a Summer" was a reference to extreme climatic hardship wrought. Colorful displays in the sky, from the optical effects of stratospheric aerosols accompanied this calamity and inspired the paintings that record these by the British painter Joseph Mallord William Turner (1775-1851) heralded in his time (by John Ruskin who deplored Darwin's ignorance of art and inability to draw) as "the only perfect landscape painter whom the world has ever seen."⁶ In North America, killer frosts and snow, even in June, July, and August, devastated New England crops and the misery is remembered as "eighteen hundred and froze to death."⁷

Plinian eruptions that likely occasioned similar, though unsung, world climatic effects were of Mt. Somna (now Vesuvius) that AD 79⁸ destroyed Pompeii, Herculanium (20 meters beneath now Portici) and Stabiano,⁹ and of Mt. Thera (now Santorini) that Late Bronze Age ca.1645 BC ejected 60 km³ of rock and, Spyridion Marinatos theorized in 1939, brought about the end of the Minoan Civilization,¹⁰ buried Akrotiri (now being excavated),¹¹ triggered earthquakes and tsunamis that swept over the surrounding islands, and possibly spawned the legend of Atlantis.¹²

Flood-basalt eruptions are prolonged outpourings that build flood/plateau/stratified/trap basalts.

Onset phreatomagmatic (while groundwater lasted) Laki fissure eruptions during 8 months of 1783, covered 580 km² of Iceland and emitted "a haze" (in million-ton units: 7 of HCl, 122 of SO₂, and, different from most volcanoes, 15 of HF) that, as recounted eyewitness Jón Steingrímsson,¹³ led to crop failure due to acid rain, the loss of most of the island's livestock by their eating fluorine-contaminated grass, and so the death of 9,000 people (one-quarter of the human residents) by famine.¹⁴ Benjamin Franklin from records of the ensuing chill European summer and winter was first to recognize that the "dry fogs" (vogs) of volcanism cool the climate.¹⁵

While flood-basalt volcanism after initial phreatomagmatism is not explosive enough to inject ash into the stratosphere, its long continued CO₂ output is another matter (*see* Topic b30). □