

Geological Society of America, Cordilleran Section, 2017, Honolulu, Hawaii  
Session T8 Explosive Volcanism

**Volcanoes control climate change with subduction-related, explosive, aerosol-forming eruptions causing slow, incremental cooling and rift-related, basaltic, effusive eruptions causing rapid warming in sequences that are sporadic and clearly not cyclic but average a few thousand years**

Large explosive volcanic eruptions form aerosols in the lower stratosphere that reflect and scatter sunlight, cooling Earth about 0.5°C for 2 to 4 years. Modelling shows this short-term cooling lowers ocean temperatures and steric sea-level for decades. Modelling and observations suggest that 5 to 10 large explosive eruptions per century increment ocean temperatures down into ice age conditions over tens of thousands of years.

Warming out of the last ice age from 11,750 to 9,375 BP was contemporaneous with the highest rate of volcanism observed in Greenland ice cores. These eruptions were in Iceland and were dominantly basaltic. Basalts are rich in chlorine and bromine observed to deplete the ozone layer, allowing more ultraviolet-B radiation than usual to warm Earth. Basaltic effusive eruptions typically ooze lava out onto the ground without exploding much into the stratosphere and thus do not form cooling aerosols.

The Dansgaard-Oeschger events, observed in Greenland ice cores, occurred at least 25 times between 120,000 and 10,000 BP when the world warmed suddenly out of ice-age conditions, typically in less than a decade, and then incremented slowly back into ice-age conditions over centuries to millennia. These sequences occurred sporadically and are clearly not cyclic but averaged 4400 years.

Rift-related, basalt flows covering large areas are contemporaneous with major warming, ocean acidification, and mass extinctions, typically punctuating geologic eras, periods, and epochs: Siberian Traps (251 Ma, 7 million km<sup>2</sup>, end Paleozoic), Central Atlantic Magmatic Province (201 Ma, 11 million km<sup>2</sup>, end Triassic), Deccan Traps (66 Ma, 0.5 million km<sup>2</sup>, end Mesozoic). Similar rapid warming over shorter time periods are contemporaneous with basaltic lava flows covering hundreds of km<sup>2</sup>: Craters of the Moon (200 BC, 700 km<sup>2</sup>, began Roman Warm Period), Eldgjá (935 AD, 800 km<sup>2</sup>, began Medieval Warm Period), Laki (1783, 565 km<sup>2</sup>, began a warm phase within the Little Ice Age), and Bárðarbunga (2014, 84 km<sup>2</sup>, causing 2015-2016 to be the hottest years on instrumental records).

Sudden warmings change food supplies causing humans to migrate. Slow cooling sets sea level, affecting migration routes. Greenland ice-core records show that

sudden warming with very low sea level occurred around 86, 73, 69, 66, 64, 61, and 36 ka. [WhyClimateChanges.com](http://WhyClimateChanges.com)