74-8 - CLIMATE CHANGE THROUGHOUT EARTH HISTORY IS CAUSED BY LARGE BASALTIC LAVA FLOWS IN SUBAERIAL RIFT ZONES CAUSING RAPID GLOBAL WARMING WHILE EXPLOSIVE ERUPTIONS IN VOLCANIC ARCS FORM AEROSOLS THAT CAUSE SLOW, INCREMENTAL COOLING OVER MILLENNIA

Tuesday, 27 October 2020

1:30 PM - 1:45 PM

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Abstract

Oxygen isotope studies in Greenland ice detail 26 times (115,000 to 10,000 BP) when air temperatures in Greenland warmed 10 to 16^{o}C out of ice-age conditions within years but then cooled incrementally back into ice-age conditions over millennia. These highly erratic, saw-toothed sequences averaged 4000 years in length.

Most explosive volcanic eruptions (VEI>=5), typical of volcanic arcs above subduction zones, eject water and SO_2 into the lower stratosphere forming aerosols that spread worldwide within months. These aerosols reflect and scatter solar radiation, cooling Earth's surface ~0.5^{o}C for a few years. Modelling shows that this cooling affects deeper ocean temperatures a century later. Just a few large eruptions per century can increment global temperatures down into ice-age conditions over millennia—the larger or more numerous the explosive eruptions, the faster the cooling.

The Bølling and pre-Boreal warmings at the end of the last ice-age were contemporaneous with 12 of the 13 best dated basaltic volcanic centers in Iceland. Throughout Earth history, large basaltic lava flows covering hundreds to millions of square kilometers in sub-aerial rift zones were contemporaneous with major, sudden warming, ocean acidification, mass extinctions, and abrupt changes in sedimentation.

This warming appears to result from depletion of the ozone layer causing less solar ultraviolet-B radiation to be absorbed in the ozone layer and more to reach Earth. The greatest observed ozone depletion was in 1992-3 following the Pinatubo explosive eruption in June 1991, causing

warming of nearly 3ºC in northern Europe and Asia during the first winter. But the aerosols were dominant, causing net global cooling. Large basaltic lava flows emit ten times more chlorine and bromine per unit volume than explosive eruptions. The heat given off by the lava appears to convect some of these gases into the stratosphere. Ultraviolet-B has enough energy to cause mutations in plants and animals well observed during the largest of the basaltic Large Igneous Provinces.

Aerosols and ozone depletion are particularly effective because they spread worldwide, affecting all incoming sunlight. The prevalence of rift volcanism versus arc volcanism is determined by plate tectonics. When subduction zones were most widespread, Earth became a “snowball”.

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