2014 GSA-RM Theme: Paleoclimatology, Paleoecology, and Evolution

CLIMATE THROUGHOUT GEOLOGIC TIME HAS BEEN CONTROLLED PRIMARILY BY THE BALANCE BETWEEN COOLING CAUSED BY MAJOR EXPLOSIVE ERUPTIONS OF EVOLVED MAGMAS TYPICAL OF ISLAND ARCS AND WARMING CAUSED BY VOLUMINOUS EFFUSIVE ERUPTIONS OF BASALTIC MAGMA TYPICAL OF SUBAERIAL OCEAN RIDGES, ISLAND CHAINS, AND CONTINENTAL FLOOD BASALTS

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Most volcanic eruptions deplete ozone ~6% for up to 10 years, allowing more high-energy, ultraviolet-B radiation to warm earth. Record low levels of ozone followed the 1991 explosive eruption of Pinatubo. Yet 6% depletion also followed the smaller and more effusive eruptions of Eyjafjallajökull (2010) and Grímsvötn (2011) in Iceland. Explosive volcanoes such as Pinatubo also eject 10-20 megatons of sulfur dioxide into the lower stratosphere, forming sulfuric-acid aerosols that reflect and scatter sunlight causing net cooling of ~0.5°C for 3 years. High rates of explosive eruptions cool earth into ice ages while continuous effusive basaltic volcanism in Iceland between 11,500 and 9,500 years ago warmed Earth out of the last ice age. Extensive flood basalts formed during the Paleocene Eocene Thermal Maximum and during times of most major mass extinctions when global temperatures rose substantially, with fossil evidence for ozone depletion. Climate change throughout geologic time appears controlled primarily by the balance of the rates of major explosive volcanic eruptions and the duration of effusive volcanism. This ratio is determined by plate tectonics and which kinds of plate boundaries are most active.

The same mechanism applies to recent global warming caused by man. By 1970, ozone depletion caused by chlorofluorocarbons (CFCs) began increasing. The Montreal Protocol took effect in 1989 stopping increases in CFCs by 1993, stopping increases in ozone depletion by 1995, and stopping increases in global temperatures by 1998.

The types and rates of volcanism appear to have been the primary driver of abrupt changes in evolution throughout geologic time ranging from causing ice ages, mass extinctions, and major changes in global climate to causing regional and local effects around specific volcanoes. For example, in the past 120,000 years, volcanism warmed the world out of the ice age within years 25 different times during the Dansgaard-Oeschger abrupt warmings but did not last long enough to warm the oceans, so the world slipped back into the ice age. These rapid changes played a major role in the migrations and evolution of homo sapiens. The longest time we remained temporarily out of the ice age was during the Upper Paleolithic Revolution.

See ozonedepletiontheory.info and a talk at tinyurl.org/ozonedepletiontheory