

## 2015 GSA Topical Session: T153. Mass Extinction Causality: Records of Anoxia, Acidification, and Global Warming during Earth's Greatest Crises

CLIMATE THROUGHOUT GEOLOGIC TIME HAS BEEN CONTROLLED PRIMARILY BY THE BALANCE BETWEEN ABRUPT WARMING CAUSED BY VOLUMINOUS EFFUSIVE ERUPTIONS OF BASALTIC MAGMA OVER MONTHS TO HUNDREDS OF THOUSANDS OF YEARS AND ABRUPT COOLING CAUSED BY MAJOR EXPLOSIVE ERUPTIONS OF EVOLVED MAGMAS OVER HOURS TO DAYS

Active volcanoes of all sizes and eruptive styles emit chlorine and bromine gases. Each eruption is observed to deplete ozone by as much as 6% at mid-latitudes for up to 10 years, allowing increased influx of high-energy, ultraviolet-B radiation to warm Earth. Effusive, basaltic volcanic eruptions, typical in Hawaii, Iceland, and Large Igneous Provinces, extrude lava for weeks to hundreds of thousands of years, depleting ozone and warming oceans. Visscher et al. (2004) conclude, for example, that during eruption of the Siberian Traps, "prolonged exposure to enhanced UV radiation could account satisfactorily for a worldwide increase in land plant mutation".

Major explosive volcanoes also deplete ozone, but in addition eject megatons of H<sub>2</sub>O and SO<sub>2</sub> into the lower stratosphere forming sulfuric-acid aerosols whose particles grow large enough to scatter ultraviolet sunlight, causing net global cooling for a few years. Sequences of large explosive eruptions increment the world into ice ages. On 25 occasions between 120,000 and 10,000 years ago, basaltic eruptions in Iceland warmed the world out of the ice age within 1 to 3 decades but failed to warm the cold oceans enough to prevent a slow return to ice age conditions. Such rapid warmings and slower coolings are now being mapped throughout geologic history in trona deposits, for example, or by using Brachiopod habitat temperatures. The relative amounts of explosive and effusive volcanism change with tectonic plate configurations.

Warming that has occurred since 1965 appears to have been caused by humans manufacturing CFC gases. By 1970, ozone depletion and mean surface air temperatures began to increase. The Montreal Protocol appears to have stopped increases of CFC emissions by 1993, stopped increases in ozone depletion by 1995, and stopped increases in mean surface air temperatures by 1998. Ultraviolet radiation absorbed on land is typically radiated back into the atmosphere at night, but it penetrates oceans to depths of tens of meters, where heat is not radiated back into the atmosphere until the whole ocean

surface warms. Oceans store ~1000 times more heat than the atmosphere. Oceans continue to warm today because ozone depletion continues at a high level.

More details at [WhyClimateChanges.com](http://WhyClimateChanges.com) and in my book *What Really Causes Global Warming?* to be released November 1, 2015.