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THE GEOLOGICAL SOCIETY OF AMERICA®

93-13: MOVING PLATE TECTONICS TO THE NEXT LEVEL OF DETAIL BY UNDERSTANDING HOW PLATE TECTONICS CONTROLS SUDDEN GLOBAL WARMING, SLOW INCREMENTAL GLOBAL COOLING, AIR TEMPERATURES, OCEAN TEMPERATURES, OCEAN ACIDIFICATION, DOMINANT SPECIES, MASS EXTINCTIONS, AND THE MAJOR AND MINOR SUBDIVISIONS OF THE GEOLOGIC TIME SCALE

Monday, 5 November 2018
11:25 AM - 11:40 AM
Indiana Convention Center - Room 243

Major, explosive, subduction related, volcanic eruptions eject megatons of water vapor and SO_2 into the lower stratosphere, forming sulfuric-acid aerosols that reflect and scatter sunlight, causing net global cooling of ~0.5 ^{o}C for 2 to 4 years. Modelling shows this short-term cooling affects ocean temperatures for a century. Many large explosive eruptions per century for 100,000 years are observed to increment the world slowly into ice age conditions—the more eruptions, the faster the cooling. Major, effusive, subaerial, rift related eruptions, on the other hand, that extrude basalt over tens to millions of square kilometers, are observed to deplete the ozone layer, allowing more UV-B than usual to reach Earth, suddenly warming Earth. The greater the extent of the lavas, the longer the eruptions, the greater the warming, the greater the acidification of the oceans, and the greater the mass extinctions. Ozone depletion explains the details of observed arctic amplification and mutations.

Widespread subduction with minimal subaerial rifting causes snowball Earth. Extensive, circum Pacific, subduction related, explosive volcanism cooled the world into the last ice age beginning ~40 Ma. Rift related, basaltic volcanism in Iceland lasting 2500 years warmed the world out of the last ice age. Shorter lived basaltic volcanism warmed the world 25 times in erratic sequences averaging just 4000 years over the past 110,000 years. Large basaltic provinces, covering up to 11 million square kilometers of land area, are contemporaneous with periods of greatest warming, ocean acidification, and mass extinctions typically ending geologic ages, epochs, periods, and even eras. Basalt flows covering hundreds of square kilometers are contemporaneous with sudden warmings throughout the Holocene.

Plate tectonics determines the relative abundance of subduction related versus subaerial, rift related volcanism, controlling climate change. When oxygen isotope data can be mass produced economically, especially in the field, the details of temperature change over millennia can be used globally to cross correlate sedimentary beds, fossils, extinctions, glaciations, and type and rates of volcanism on millennial time scales, providing far more detail than magnetic anomalies that allowed us to decipher the details of plate tectonics.

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