Assessing the potential impact of super-eruptions on society and the environment

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Rare, but extremely large, explosive super-eruptions (Magnitude 8 and above, or > 1015 kg of magma, or > ~ 450 km3 of rhyolitic magma,) have occurred throughout geologic time. How frequent they have been, and will be, has been estimated in the range of one per 100,000 years. With the latest Toba event (YTT) at 74 ka ago, human society should perhaps not be overconcerned about such events. However, the most recent attempt to estimate a mean return period for Magnitude 8 events is one every 17,000 years, which puts a different slant on the future likelihood of a super-eruption. A Magnitude 7 event seems to occur on average once or twice per thousand years, and a recurrence of even these (Tambora or Campanian Tuff-sized eruptions) presents a significant challenge for future societies.

Super-eruptions of silicic magma lead to the catastrophic formation of huge calderas, devastation of substantial regions by pyroclastic density currents or flows and their deposits, and ashfall deposits that can cover continent- size areas. Widely dispersed fine ash means that the effects of future super-eruptions may be felt globally or at least by a whole hemisphere. The most widespread and long-lasting effects are likely to derive the volcanic gases released, primarily sulfur gases that are converted into sulfuric acid aerosols in the stratosphere. These will remain for several years, promoting changes in atmospheric circulation and causing surface temperatures to fall in many regions, leading to short-term temporary reductions in light levels and severs and unseasonable weather ("volcanic winter"). However, the radiative impacts of the aerosols are not expected to be severe enough to cause major climatic changes, and, indeed, some super-eruptions may not release huge amounts of sulfur gases. If a future super-eruption were predicted what would, or could, society do? Major disruptions to global societal infrastructure can be expected for periods of months to years, and the cost to global financial markets will be high and sustained. Preparation for such low-probably but high-consequence events is difficult to imagine, yet some modest early measures can be considered. Volcanologists should refine geologic histories and ensure at least baseline monitoring of candidate volcanoes. They should consider how they will judge the likelihood that an impending eruption will be of super-eruption scale.

Biography: Steve Self has studied volcanic rocks in many parts of the world, concentrating on flood lava effusions, explosive eruptions, and the impact of volcanism on the atmosphere. Current research interests include mechanisms and products of flood basalt and explosive super-eruptions and other projects (see www.stephenself.com). He has published and lectured widely on the impact of large-scale volcanic eruptions on the environment and society, relevant to both our present and future world, and past Earth history. He retired in 2017 from his position as Senior Geologist/Volcanologist with the US-Nuclear Regulatory Commission. He was Chair of Volcanology at The Open University (2001-2008) in England, UK, and a past leader of the UK Volcanic and Magmatic Studies Group. Before 2001 he was Professor of Geology at the University of Hawai'i-Mānoa. Steve is currently an Adjunct Professor with the Earth and Planetary Science Department at UC, Berkeley. He is a Life Member of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), and was Vice-President of IAVCEI up to 2016. Steve is a Fellow of the American Geophysical Union, GSA, and the Geological Society (London).