Séminaire LGGE

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"The A.D. 1257 climactic eruption of Rinjani-Samalas (Lombok, Indonesia): eruptive dynamics and volatile release"

Céline Vidal
Laboratoire de Géologie des Systèmes Volcaniques, IPG, Paris

Plinian eruptions are among the most catastrophic events as they discharge large amounts of ash, sulphur and halogen gasses into the stratosphere as a result of explosive fragmentation of large volumes of gas-rich magma. Despite their low frequency of occurrence, these powerful explosive eruptions can have devastating impacts on both local and global scales. The study of the eruptive dynamics of such events is necessary to improve modelling and forecasting of future events. The long-called "A.D. 1258 mystery eruption" associated to the largest sulphate aerosol spike of the last 7000 years recorded in polar ice cores has recently been sourced to a Mount Samalas caldera eruption in the Rinjani volcanic complex (Lombok, Indonesia). Dated at A.D. 1257, this eruption is estimated to have released ca. 40 km3 of trachytic magma (dense rock equivalent) in a total of ca. 26 hours. This complex multiphase ultraplinian eruption involved: 1) the widespread dispersal of tephra from a convective eruption column that reached heights of up to 43 km which can be easily traced at least to Bali, 125 km west of the caldera; and 2) the emplacement of voluminous column-collapse pumiceous pyroclastic density currents that blanketed the northern half of Lombok and entered the sea producing a co-ignimbrite ashfall traceable in the surrounding islands. With a magnitude of 7 and an intensity of up to 12, it thus ranks among the largest explosive eruptions of the Holocene. Here we present an unprecedented phase-by-phase reconstruction of the eruption dynamics based on extensive fieldwork and data analysis using the most recent models and recommendations of the International Association of Volcanology and Chemistry of the Earth's Interior commission on tephra hazard modelling. Furthermore, geochemical analysis of melt inclusions enabled us to assess that about 136 megatons of SO2 and 35 megatons of chlorine were released at time of eruption. We also evaluate the contribution of a pre-existing volatile-rich phase onto the sulphur budget. By linking the geochemistry of the magma and the eruptive dynamics we provide a magma-to-stratosphere dataset of the degassing and hence key information for both distal tephra dispersal and climate modelling of an eruption suspected to have impacted climate on a global scale and particularly to have played a role in triggering the Little Ice Age.