Evolution of the erutive plume through image and tephra analysis and physical plume modelling, study of the Eyjafjallajökull 2010 eruption.

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On April 17th and 18th, 2010, the Eyjafjöll volcano (Iceland) erupted $27x10^6 m^3$ of tephra during an initial phreatomagmatic phase. Most of the emitted tephra was carried out to sea due to strong northerly wind dispersing ash towards Europe. On April 17th, the eruptive activity was characterized by a pulsating behaviour and the formation of a bent-over plume featuring collapse-like features. We document the behaviour of the plume formed on April 17. Videos from a camera pointing at the summit of the volcano were analysed to reconstruct the plume's rise velocities and travel trajectories, and to record the evolution of the eruptive activity. Tephra density measurements and reconstruction of total grain-size distribution were undertaken to complete the eruption source parameter requirements and atmospheric parameters were obtained from observations recored by Iceland Meterological Office. These were used as input parameters for a one-dimension physical model (PPM; Michaud-Dubuy et al., 2018) of explosive volcanic plume to simulate the time evolution of the explosive activity and the eruption plume behaviour in a stratified atmosphere under windy and still conditions. The model output is a buyoant plume heavily effected by the strong wind that prevailed during this stage of the eruption, yet did not produce a full or partial collapse of the plume. This outcome agrees well with observations. The explosive activity produced tephra that is a mixture of dense juvenile lithics and highly vesicular pumices in roughly equal proportions. We interpret this to imply that a sluggish plug was formed repeatedly, due to degassing and cooling, in the top section of the volcanic conduit. It periodically paused the explosive activity, which resumed when the accumulated pressure placed on the plug by the rising magma overcame its tensile strength. Cyclic repeat of this process resulted in the pulsating explosive activty that typified the eruption. Formation of accretionary lapilli in the early phreatomagmatic phase induced premature sedimentation of the ash grade component in the plume and thus increased its buoyancy. The simulated average altitude of the plume (e.g. 6627 m.a.s.l.) indicates a discharge of 5.10^5 $kg.s^{-1}$, which compares to the lower end of the estimated average discharge proposed by Gudmundson et al., (2012), i.e. 5 to 10.10^5 $kg.s^{-1}$. This type of plume studies have important implications for assessing potential volcanic hazard in Iceland, because it can be used to investigate if and how changes in eruptive behavior of explosive eruptions may affect the potential hazards. We have extended this type of plume study to one of the largest basaltic explosive eruption in Iceland, the Veiðivötn 1477 CE event (V1477). It erupted from an ~65 km long discontinuous volcanic fissure and produced ≥10 km^3 of freshly fallen tephra that covered an area of ~53,000 km^2 (about half of Iceland). The goal is to retrieve key eruption source parameters via field observations and use them to numerically model the V1477 plumes to obtain better insight onto the eruption behaviour of this spectacular basaltic phreatoplinian event.

References

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