Volcanic hazard mapping based on eruptive histories and eruptive volumes - A case study from the Auckland Volcanic Field (New Zealand)

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Volcanic field-scale spatial and temporal magma fluxes are often used to express the long-term volcanic hazard associated with monogenetic volcanic fields. In addition, the temporally ordered eruptive volumes are key information to assess the field's long-term eruptive behaviour (i.e. ascribe time or volume predictability). However, these descriptions of volcanic hazard and volcanic field evolution provide only limited information about the edifice-scale volcanic hazard related to a future vent opening. The eruptive volume, as an important parameter for long-term volcanic hazard assessment, is also essential for the edifice-scale hazard classification. However, the accuracy of this parameter is hampered by the high susceptibility of volcanic edifices to significant erosion in a relatively short time (e.g. 1 000 to 100 000 yr) after their eruption. The remobilization of tephra after an eruption also creates uncertainty in eruptive volume calculations. Determination of eruption style is also important for better understanding of area will be area affected by future volcanism (e.g. difference in distribution of phreatomagmatic pyroclastic density current deposits versus scoria fall deposits). All these input data should be applied when quantifying likely eruptive scenarios and describing the spatial context of volcanic hazards in monogenetic volcanic fields. In this study, an edifice-scale investigation of eruptive volumes and eruption histories was performed on the Quaternary Auckland Volcanic Field with the aim of constructing volcanic hazard maps. The eruptive volumes, which were corrected to Dense Rock Equivalents (DREs), were interpreted and assigned to dominant eruption styles recorded for the specific edifices such as phreatomagmatic and magmatic. These volumes (genetic-unit-based eruptive volumes) were used subsequently to understand the proportion of magma fragmented by a certain eruption style. Four eruptive scenario types were distinguished: (1) pure magmatic volcanoes (e.g. scoria cones with lava flows), (2) volcanoes with short-lived phreatomagmatic eruptions and long-lived magmatic phases, (3) volcanoes with long-lived phreatomagmatic, and short-lived magmatic, stages (e.g. tuff rings with an intra-crater lava lake and scoria cone), and (4) pure phreatomagmatic volcanoes (e.g. maars). These groups form a gradual transition from one to another that reflects the variable influences of climate, topography, and substrate geology, across different spatial locations and over time during the life of the field. Within each of these groups, there is a wide range of volumetric variability from 0.001 to 0.6 cubic km, with an average of 0.03 cubic km. This approach can be adapted to improve the volcanic hazard mapping of monogenetic volcanic fields worldwide, which ideally could be further developed by building a database of individual eruption properties from a range of similar fields in other areas.