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Susceptibility analysis of phonolitic eruptions at Teide volcano (Canary Islands)

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An important unknown in short-term and long-term volcanic hazard assessment is the location of future eruptive vents. This question has not a simple answer, in particular if we consider a very wide area in which recent activity has occurred from, in appearance, randomly located vents, or composite volcanoes hosting flank and central vent eruptions. This later is the case of Teide, on the island of Tenerife (Canary Islands), which has undergone effusive and explosive eruptions (basaltic and phonolitic) at its flanks and main central vent during the last 20,000 years. Apparently, there is no structural or petrological pattern that could control such a random vent location. The lack of historical data on precursory activity at Teide (the last eruption occurred 1000 years ago) and of a good surveillance network makes the identification of future vents even more challenging. It is generally assumed that future eruptive activity on Tenerife, if any, should be of basaltic nature, far from the central Teide system, and generate short lava flows and a small cinder cone. However, there is no scientific reasons to rule out the possibility of an eruption from Teide. On the contrary, all the available petrological, geochronological and volcanological data, suggest that Teide cannot be considered as an extinct volcano at all.

As a first step to assess the hazard from Teide volcano, we have performed a susceptibility analysis of phonolitic eruptions, as they represent the most hazardous eruptions that we could expect in this case. We define volcanic or eruptive susceptibility as the spatial probability density function for the opening of a future vent. In other words, we try to identify the possible path that magma will follow to reach the surface in the next eruption. For a long-term estimate of volcanic susceptibility we need to take into account all relevant geological information (locations of previous vents, structural

lineations, stress field information, etc), while for a short-term assessment (volcanic crisis or unrest episodes), we need to consider the monitoring data, too. In the case of Teide we can only use geological information, which shows that phonolitic eruptions have occurred either at the flanks or from the central vent of the volcano, but no significant differences exist between them regarding the eruption style and composition or volume of the products. The morphology and size of the volcanic edifice have been changing during the last 20,000 years, but this has not affected the random pattern followed by the location of new eruptions. In order to determine the causes of central and flank phonolitic eruptions at Teide, we have preformed several numerical experiments considering a wide range of situations in which the main physical conditions (topography, size, depth and shape of the magma chambers, presence of deviatoric stresses, internal structure of the volcano) of the volcanic system have been changed. The results obtained show that the pathway that magma will follow from the reservoir to the surface depends on the local stress field distribution, which is basically controlled by the magma chamber shape and the regional stress field (e.g. extensive, compressive). This suggests that in the case of Teide, where there is apparently not a preferential location for new vents, each new phonolitic eruption is preceded by a morphological change of the magmatic reservoir.