

Utilizing probability analyses to predict the long-term spatial patterns of monogenetic volcanoes in southwest Japan

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The assessment of long-term geologic hazards has become an essential issue in society due to the requirement of constructing some types of modern facilities such as nuclear power stations or high-level radioactive waste repositories in areas of low geologic risk. Volcanism is a low-frequency, high-consequence geologic hazard. In an active volcanic arc such as Japan, the long-term spatial and temporal distribution of volcanism needs to be estimated. Over a long period of time, magma will either be fed to the surface many times via the same conduit resulting in a polygenetic volcano or once through a single dike generating a monogenetic volcano. The spatial distribution of monogenetic volcanoes is much more difficult to estimate than for polygenetic volcanoes because the location of the next eruption forming a new volcano is different. Current knowledge of the complex geological factors and natural processes controlling the locations of monogenetic volcanoes is insufficient to estimate future spatial and temporal patterns. One way to estimate the future patterns of monogenetic volcanoes is through probabilistic analysis. Over the past two decades, probabilistic analyses have been used to construct probability maps showing the long-term spatial distribution estimates of future eruptions in several volcanic fields in the US and Mexico. One prominent example includes the Yucca Mountain region; site of the US's proposed high-level radioactive waste repository which is located near approximately 40 basaltic vents formed since 10.5 Ma. The probability analyses are dependant on the location and ages of vents, and have the added benefit of revealing volcano alignments and clustering, in addition to estimates of the probability of eruption.

In Japan, a lot of research has been focused on the construction of volcanic hazard maps in the event of a volcanic eruption - the consequences of volcanism - but not on the probability of new volcanic edifices forming within or nearby volcanic fields. We present here the results of probabilistic analyses of the Kannabe Monogenetic Volcano Group and nearby monogenetic volcanoes located in east San-in district, southwest Japan, using data from approximately 40 monogenetic volcanoes. Application of a spatial analysis reveals that vents: (1) show local NW-SE trends, similar to the trends of dikes and active faults in the region; (2) cluster at various scales. Probability density maps show that the one in 10,000 chance of an eruption occurring in the next 10,000 years covers a broader area (approximately three times) than that of the Yucca Mountain region in the US.