Probabilistic based models used for assessing new volcano formation and the existence of concealed active faults –The main challenges and outlook

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In Japan, assessing the stability of the geological environment, including the distribution of active faulting and new volcano formation and/or volcanic eruptions exceeding a critical magnitude is necessary when carrying out site selection for locating nuclear facilities such as nuclear power plants, spent fuel reprocessing facities as well as geological repositories or surface storage facilities of radioactive wastes etc.

Due to a limited understanding of the mechanisms and processes controlling the location of volcanism and active faults, statistical and probablistic based approaches have been increasingly developed and applied over the last 10 or 20 years to evaluate the risk imposed from such natural phenomena in a given area of interest. The methodology is more established for evaluating new volcano formation and/or repeated eruptions than the existence of active faulting. This is mainly because when a volcanic event i.e. an eruption, occurs, evidence, namely, the eruption products, tend to remain in at least the recent (e.g. < 1 Ma) geological record. In the case of active faulting, the situation is almost opposite where more recently formed active faults are harder to detect than more established active fault zones. In particular, younger active faults have initially smaller cummulative displacements compared with older and more mature active faults and can therefore be harder to detect in 2-D seismics. This is especially the case in crystalline or Neogene paleo-volcanic fractured rocks. Even when faults are identified, there is then the added challenge of showing that they are active or not. Examples of this include the western Tottori region where two recent earthquakes occurred along two separate unknown faults; the Mw 6.6 2000 Tottori earthquake (6 October 2000) and the Mw 6.2 2016 Tottori Earthquake (21st October 2016).

This presentation summaries and discusses the models developed so far for assessing new volcano formation and for evaluating the spatial distribution of concealed active faults based on the distribution of known active faults. In both cases, the parameters that have the largest impact on the calculated risk are temporal frequencies (number of events per unit time) and spatial density (number of events per unit area). In the case of new volcano formation, the key frequency based parameters are volcano density and clustering, eruption ages (including formation of new volcanoes), and eruption volumes. For active faulting, key frequency based parameters are known active fault segment distribution, initiation ages, historic seismicity and slip rates. The temporal datasets for active faults are far more sporadic and uncertain compared with volcanic events.

An overall aim of the probabilistic approach is, idealy, to be able to reduce the uncertainty and/or improve confidence in the calculated probabilities as new data becomes available. For both volcanism and active faulting Bayesian statistics have been used to combine additional datasets. This presentation will discuss the applicability of the probablistic based models developed so far and what needs to be developed further in future.

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