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Volcanic risk assessment – probability and consequences

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Risk is the product of the probability and consequences of an event. Both of these must be based upon sound science that integrates field data, experiments, and modeling, but must also be useful to decision makers who likely do not understand all aspects of the underlying science. We review a decision framework used in many fields such as performance assessment for hazardous and/or radioactive waste disposal sites that can serve to guide the volcanological community towards integrated risk assessment. In this framework the underlying scientific understanding of processes that affect probability and consequences drive the decision-level results, but in turn these results can drive focused research in areas that cause the greatest level of uncertainty at the decision level. We review two examples of the determination of volcanic event probability: (1) probability of a new volcano forming at the proposed Yucca Mountain radioactive waste repository, and (2) probability that a subsurface repository in Japan would be affected by the nearby formation of a new stratovolcano. We also provide examples of work on consequences of explosive eruptions, within the framework mentioned above. These include field-based studies aimed at providing data for "closure" of wall rock erosion terms in a conduit flow model, predictions of dynamic pressure and other variables related to damage by pyroclastic flow into underground structures, and vulnerability criteria for structures subjected to conditions of explosive eruption. Process models (e.g., multiphase flow) are important for testing the validity or relative importance of possible scenarios in a volcanic risk assessment. We show how time-dependent multiphase modeling of explosive "eruption" of basaltic magma into an open tunnel (drift) at the Yucca Mountain repository provides insight into proposed scenarios that include the development of secondary pathways to the Earth's surface. Addressing volcanic risk within a decision framework is an important way to focus research in the most critical areas as well as providing an integrated approach to a range of complex processes. Uncertainty in both event probability and consequences can formally be accounted for within a decision framework and therefore is explicitly communicated to decision makers. Such an approach also tends to open new questions about volcanic systems and their interactions with humans and infrastructure, thereby driving new basic research.