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# Multi-parameter modeling of hydrothermal fluid circulation.

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Monitoring of geophysical and geochemical parameters is one of the key resources available for short-term hazard evaluation and for understanding the state of a volcano. The underlying concept is that measurable changes in such parameters are expected to occur, as a volcano approaches eruptive conditions. In particular, volcanic fluids are expected to provide important information on the state of the magmatic system. Different processes, however, may occur and affect hydrothermal fluids, as they rise toward the surface. Changes in rock properties, physical and chemical interaction with shallow waters and with the porous rock may all result in highly variable surface phenomena. On the other hand, the presence of an active and widespread hydrothermal system may significantly alter rock physical properties, affecting their response to volcanic unrest and, in general, the evolution of different observable parameters. Because of this complexity, the interpretation of monitoring data should be based on different data sets, in order to consistently integrate different kinds of signals and data into a unique and congruous conceptual model.

Physical models describing different geophysical and geochemical parameters allow testing the reliability of different conceptual models. Numerical simulations of a multiphase, multicomponent fluid and heat flow through porous media are carried out to describe the evolution of a hydrothermal system fed by a deep, magmatic source. A parametric study was performed to evaluate the role of different source properties on the evolution of observable parameters, such as gas composition or gravity changes. Results suggest that source perturbation may lead to changes in observable parameters that last much longer than the source perturbation itself. Simulations highlight the sen-

sitivities of different parameters to different source properties and suggest that largest effects are to be expected from changes in the degassing rate at the magmatic source. Rock properties, initial, and boundary conditions also play a major role in controlling both short- and long-term response of the hydrothermal system to volcanic unrest.