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The rocks and the fluids. The complex sound of the hydrothermal activity

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Volcanic gases and aqueous fluids permeate the rocks in volcanic areas and feed a wide range of surface phenomena, such as hot springs, fumaroles, and diffuse degassing. Measurements of fluid temperature and composition provide information on the source of discharged fluids, and are commonly carried out in volcanic areas to gather information on the state of magmatic degassing at depth. The presence of hydrothermal circulation, however, generates different kinds of signals, including changes in gravity, electrical resistivity, or ground deformation. These signals form as temperature, pressure, and phase distribution change through time and space, possibly due to a variable activity of different fluid sources. At the same time, the circulating fluids are affected by the nature and properties of the subsurface rocks. The extent and velocity of fluid propagation, and the magnitude of surface phenomena are governed by the rock permeability and by the presence and geometry of fractures. The hydrothermal activity and the related signals, result from the complex interactions between one or more fluid sources and the porous medium through which the fluids propagate. Numerical modeling of multi-phase and multi-component hydrothermal circulation is used to simulate the signals generated by the hydrothermal activity under various choices of rock properties and boundary conditions. Result highlight the importance of heterogeneous rock permeability and illustrate the different sensitivities of the considered observable parameters to changes of the source and of the medium properties. Modeling results may provide a useful framework for the interpretation of monitoring data collected in volcanic areas.