When circulation gets tough, the TOUGH gets going. Modeling of hydrothermal fluid circulation in active volcanic areas

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Numerical modeling of hydrothermal fluid circulation has been prompted by a wide variety of industrial needs, ranging from nuclear waste disposal and geothermal energy exploitation, to the more recent applications devised for environmental remediation and carbon sequestration. Volcanological applications had a later start, hindered by the formidable challenges posed by poorly-constrained and extreme system conditions, joined with a chronic lack of founding and good-quality, modeling-oriented data sets. Nevertheless, as the volcanological implications of hydrothermal activity are important, modeling of fluid circulation in active volcanic system has become more popular in recent times. Modeling results provided useful hints on the evolution of active volcanic systems, by illustrating the role of an evolving source of volcanic gases and showing the diversity of the geochemical and geophysical signals that can be generated by fluid circulation. Numerical simulations also showed how these signals can be modulated by the properties of the rocks, and by their temporal and spatial evolution. This talk will provide an overview of the volcanological applications of hydrothermal circulation models, highlighting the strength and weaknesses of this approach, and discussing future developments. In particular, a promising research direction is the application of inverse modeling of hydrothermal fluid circulation as a tool for the assessment of volcanic system conditions. Preliminary results from the first application to the well known Campi Flegrei caldera will provide an opportunity to discuss potential and problems of the inverse approach to the interpretation of monitoring signals.