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Stress field and ground deformation at volcanoes: Influence of reservoir multiplicity and host rock lithology

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In recent years, measurements of surface deformation have come to provide a useful mean of studying volcanic processes. A variety of source mechanisms have been proposed to account for the observed volcano deformation, including magma intrusion, slip along faults, or pore pressure variations in transient hydrothermal systems. Some causative sources may be cause for concern, e.g. pressure changes in shallow magma reservoirs or intrusive events, while others may not. Since it is difficult to directly identify causative processes at depth, they need to be inferred by the analysis of observables. Numerical models provide a link between measured ground deformation and the inaccessible deformation source. Substantial effort has therefore gone into the development of forward and inverse prediction schemes that strive to characterize sources properties from recorded data and vice versa. Here we present a set of new results from numerical forward modelling using a Finite Element Method with nodal implementation. In our models we assume the surrounding crust behaving as a linear elastic medium. In this presentation we report results from simulating the theoretical stress distribution and resultant vertical and horizontal deformations in a volcanic area due to pressure changes in one or more shallow sill-like magma reservoirs surrounded by variable mechanical properties of the host rock. We find that the amplitude and wavelength of resultant ground deformation is strongly dependent on the distribution of mechanically stiff and soft lithologies. Surface deformation caused by pressurizing multiple reservoirs may be a result of simple addition or complex superposition of stresses leading to either straightforward amplification or distortion of deformation

patterns, depending on the relative position of and distance between the reservoirs.