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# Self-potential, Ground-tilt and Infra-Red Emission Associated with Geyser Eruptions: Implications for Volcanic Monitoring-II.

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Self-potential (SP), ground deformation (GD) and infrared (IR) monitoring play extremely important roles in volcano hazard assessment since they can provide valuable constraints on the depth, pressure, shape and temporal changes of both sub-surface deformation sources and surface flow patterns of hydrothermal and magmatic fluids and eruptions. However, GD in volcanic regions has usually been interpreted to result only from magma emplacement whereas recent observations of relatively rapid GD fluctuations suggest pressure transients from fluid/gas phase changes and/or hydrothermal poroelastic deformation may also contribute. Unfortunately, GD measurements that are unequivocally induced by multi-phase pressure transients with no magma involvement are rare and this has limited our ability to understand one of the major contributors to volcanic unrest. Geysers are intermittently erupting hot springs that occur when gas-rich high-temperature fluids flash to steam as a result of changing fluid/pressure/temperature conditions. These are excellent analogues to volcanoes because both systems are characterized by cyclic phenomena triggered by phase changes and fluid flow can be inferred from SP measurements. In 2009 and 2010, we documented deformation and flow in the absence of magma emplacement with measurements of SP, ground tilt (GT), IR and other parameters at the “Old Faithful” geyser in northern California and “Lone Star” geyser in Yellowstone National Park. Taking “Old Faithful” geyser as an example, the GT, SP and water outflow cycles are observed to be quasi-sinusoidal with a 4-5 minute periodicity. All are in phase except the surface eruptions. Surface eruptions occur during initial deflation about a minute after peak ground uplift and SP. The eruptions continue for about a minute sometimes with an associated small deflation/inflation pulse corresponding to first clearing then recharge of the conduit. Larger-scale deformation monitoring indicates the existence of several interacting fluid pressure sources. These observations suggest that subsurface pressure transients associated with phase

changes in porous and fractured media occur at relatively shallow depths (<60m) with complex and time-variable geometry and are easily detectable with modern deformation techniques. These results are consistent with observations in volcanic regions where magma is present, and suggest that deformation techniques, together with SP and seismic monitoring, may provide an effective means for identifying and separating magnetic intrusion and subsurface hydrothermal effects.

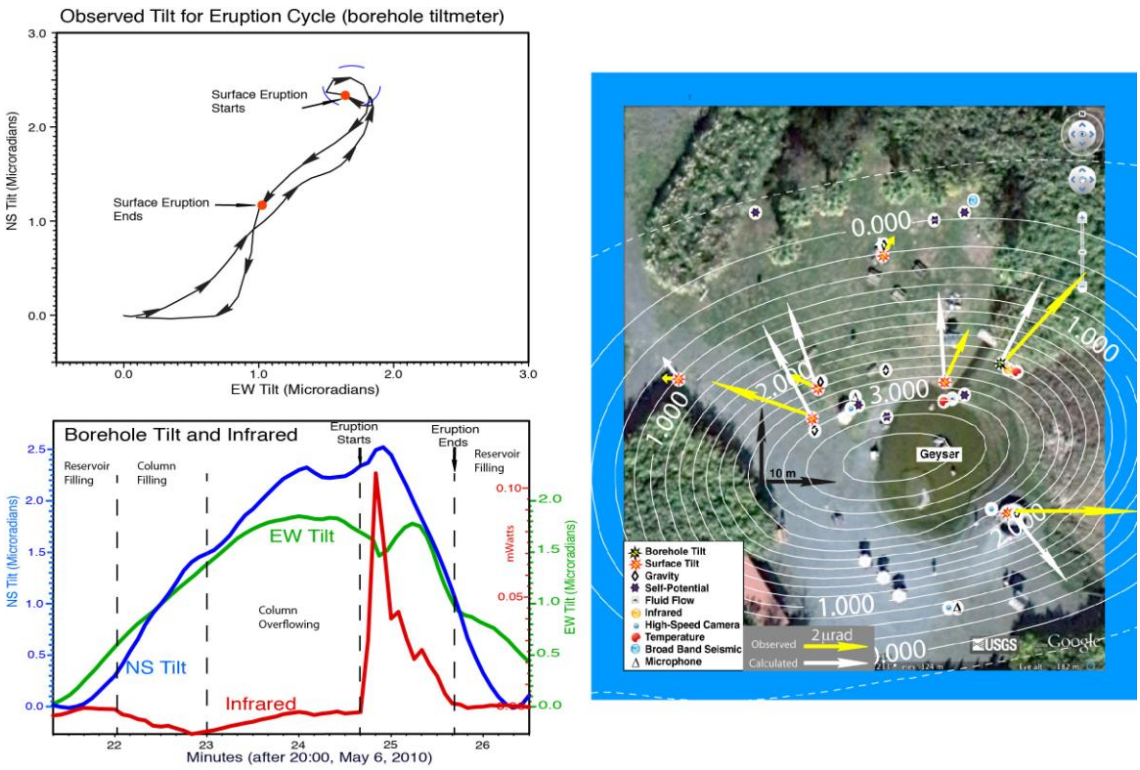


Fig 1. Deformation evolution during an eruption cycle of Old Faithful Geyser at Calistoga, California.