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1 Externally driven Tilt Anomalies faking internal Pressure Changes – a 3D-Finite Element Study for Merapi Volcano

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A prerequisite for a successful assessment of volcanic hazard is a proper discrimination of signals related to volcanic activity and non-volcanic origin. This is especially valid for volcanoes such as Merapi which are continuously active on a certain pressure level with only small fluctuations. In that case, environmental disturbances gain importance and require a thorough investigation.

The continuous tilt records obtained at four deformation stations along the hillsides of Merapi Volcano are dominated by rain- and ground water signals. Two kinds of disturbances are identified: (1) short period variations which are successfully removed from the tilt records by convolving local rain data with time functions describing loading and diffusion processes; (2) rapid, step-like drift changes which are probably not related to individual rain events. Type-2 signals, which are highly correlated between the four stations, cannot be corrected by the existing convolution approaches.

3D Finite-Element-Modeling shows that sign and relative amplitudes of type-2 signals in radial direction are compatible with a pressure source located in the central part of the volcano edifice. The model geometry includes a Digital Elevation Model with a resolution of 15 m. Thus, the model accounts also for effects of local, small-scale topographic features on tilt measurements and can investigate pressure induced

tilt signals in tangential direction. However, in contrast to the radial component, the observed type-2 signals in tangential direction are not compatible with an internal pressure variation. We conclude that: (1) externally and internally induced radial tilt disturbances along the flanks of Merapi Volcano may have similar spatial characteristics; (2) a discrimination between the two sources may be possible by comparison of tangential tilts. However, a quantification of the strong influence of the local topography on the tangential tilt needs a further refinement of the local discretization near the tiltmeter stations.