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The Dynamics of Prolonged Unrest at Caldera Volcanoes: Insights from Joint and Simultaneous Potential Field, Geodetic and Seismic Records at Nisyros, Greece

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Gravity and deformation time series data are employed to quantify long-term subsurface dynamics at restless calderas and for forecasting volcanic activity. Critical to the interpretation of residual gravity data in terms of magma dynamics, is the assessment of signals stemming from phenomena such as, for instance, secular variations in the level of the ground water table and the mass/density changes in active hydrothermal systems. Our earlier study at the restless Nisyros caldera in Greece revealed short-term (40-60 min) gravity variations with amplitudes similar to those observed during annual microgravimetric surveys. We speculated that these short-term variations might be caused by the hydrothermal/magmatic degassing process. In this paper, we report results from multi-parameter observations made at the caldera in May 2006, using one continuously recording gravimeter, two field gravimeters, three GPS receivers, one seismometer, one very-low-frequency (VLF) receiver and one audiomagnetotelluric (AMT) receiver. The obtained multiparameter time series reveal non-steady short-term oscillatory signals. The dominant period of oscillation (40-60 min) indicates short-term processes most likely associated with instabilities in the degassing process, causing thermohydromechanical disturbances of the hydrothermal system. These disturbances constitute the majority of geophysical signals recorded at the ground surface

and hence dominate activity at this restless caldera. Our analysis presents an important quantitative study of the background dynamic processes at a restless caldera. Aqueous fluid migration must be regarded as an important mechanism for prolonged unrest periods and efforts should be made to obtain multi-parameter continuous time series. Magmatic signals must exceed shallow hydrothermal signals in order to be seen during geophysical monitoring programs.