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3D Imaging of Brittle/Ductile transition of the crust beneath the resurgent calderas

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Rheology is a crucial factor to understand the mechanical behaviour and evolution of the crust in young and tectonically active belts. The aim of this paper is to investigate the rheological properties of the crust beneath resurgent calderas as Long Valley caldera (California USA) and Campi Flegrei (Southern Italy). Through the rheological proprieties of the calderas area, we highlight the driving process that determine the cut off of the local seismicity [K. Ito, 1993].
In this context, we consider the thermal proprieties and mechanical heterogeneity of the crust in order to develop a 3D conductive time dependent thermal model of the upper crust beneath the two calderas. More specifically we integrate geophysical information (gravimetric, seismic and boreholes data) available for the considered area in FEM environment [Manconi A. et al., 2010]. We performed a numerical solution of Fourier equation to carry out an advance optimization of the real measured data. We produce a set of forward models and propose, in order to analyse and solve the statistical problem, the Monte Carlo optimization procedures as Genetic Algorithm [Manconi A. et al., 2009]. In particular we search for the heat production, the volume source distribution and the surface emissivity parameters that providing the best-fit of the geothermal profiles data measured at boreholes, by solving the non stationary heat flow equation (Campanian Ignimbrite eruption about 40 kyr for Campi Flegrei caldera and Bishop tuff eruption about 700 kyr for Long Valley caldera). The performed thermal fields allow us to obtain the rheological stratification of the crust beneath two resurgent calderas; the models suggest that the uprising of a ductile layer which connects the upper mantle to the volcanic feeding system could determine the stress conditions that controlled the distribution of seismicity. In fact, the computed 3D imaging of Brittle/Ductile transition well agrees with the seismic hypocentral distribution in the two volcanic area [Solaro G. et al., 2007].
The rheological model could be taken into account, as first order approximation, to better understand the mechanical behaviour that governs the active deformation process in thermal anomalous regions as the case of volcano environments.

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