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Building and interpreting a database to understand recent caldera unrest from monitoring data

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Calderas are among the most spectacular, dangerous and active volcanoes on the Earth. Activation of seismicity, surface deformation and anomalous degassing are commonly observed at many calderas, denoting unrest. The unrest can be intermittent, lasting for months to years, or persistent, over decades to centuries. Although most caldera unrest episodes do not lead to an eruption, the possibility of an impending eruption warrants detailed monitoring and study. To better understand caldera unrest, we built a database from all available publications and reports on the recent unrest episodes at calderas in the world. We focused our attention on the unrest episodes which have occurred in the last 25 years, being complementary to Newhall and Dzurisin (1988). We considered the monitoring data from more than 45 unresting calderas, 35 of which characterized by eruptions. Attention has been given to seismicity, deformation and gas variations, along with their possible interaction. The database consists of an excel sheet containing the: (a) caldera descriptive parameters (caldera name, UTM coordinates, maximum and minimum diameter, area, date of last eruption, magma composition); (b) seismic data (width, maximum and minimum depth of area undergoing seismicity, frequency and duration and maximum magnitude; (c) geodetic data (location and width of deformed area, intensity and duration of the deformation); (d) geochemical data (location of anomalies, changes in maximum temperature, variations in chemical composition, duration of the anomaly, pH changes); (e) presence of eruptions and their characterization.
The preliminary analysis of the database confirms that all eruptions are preceded by an unrest episode, but not all unrest episodes culminate in an eruption; this suggests that these indicators are a necessary condition to establish the state of unrest, which may anticipate an impending eruption; however, the indicators are not always adequate to determine the occurrence of any eruption. Seismicity seems the most widespread/reliable indicator for the state of unrest. Where clearly established, the cause of unrest is magmatic. Very different unrest trends have been observed to occur before an eruption; most unrest episodes show a linear trend, characterized by the increase of the intensity of an indicator; however, in about one-third of the considered cases, mostly related to silicic calderas, non-linear trends have been observed, suggesting unpredictable behaviors before eruptions. This qualitative analysis will be followed by a more quantitative statistical analysis of the measured parameters, in order to better constrain caldera unrest and its possible culmination in eruptions.