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The challenges of archiving and comparing deformation data for interpreting volcanic unrest

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The most challenging task during volcanic crisis is to interpret multi-parameter monitoring datasets, to anticipate the evolution of the unrest, and to make an informed decision that allow implementation of timely mitigation actions. This requires comprehensive real-time monitoring data but also a background eruptive history and past unrest data of the volcano. However, many volcanoes have limited instrumental records of past eruptions (or none!) and thus an assessment needs to be made by comparing its activity to analogue volcanoes that may have more complete records. Such analysis requires a standardized and organized data archiving of global historical unrest in a centralized database which is the purpose of WOVOdat project ([1]; wovodat.org). WOVOdat integrates records of multi-parameter datasets (seismic, deformation, gas, thermal etc), from instrumental and observational, in a common standardized format where all data are time-stamped, geo-referenced, and supported with metadata information (e.g. instrument, station, processing method/technique, data owner). The data are archived as an inter-relational structure, to allow spatio-temporal multi-parameter data visualization and analysis allowing for comparison across different unrest and volcanoes. Current deformation data in WOVOdat come from a variety of sources including UNAVCO (USA), GNS (New Zealand), JMA (Japan), and data types: GPS, tiltmeter, levelling, EDM, strain meter, from about 100 volcanoes and covering 130 unrest episodes. Other efforts on compilation of deformation data are also underway [2,3,4].

A challenging aspect of compiling and interpreting deformation data related to volcanic unrest is the 4 dimensional (4-D) aspect of the problem: deformation is heterogenous in space and time. Moreover, there is large variety of instruments that record different physical parameter, and in many cases it necessary to the post-processing of the acquired data, and the organization of the data in a manner that can be interpreted together the time series comparison with other unrest data such as seismicity. For example: (1) instrument settings & sensitivity (e.g. gain, direction, location relative to the vent, ground based or remote sensing, sampling rate, continuous or campaign survey), (2) different data-type reflect different physical parameter and unity: GPS displacements (X-Y-Z component); GPS baseline changes (distance between 2 stations); EDM (distance changes); tilt meter (radial- and tangential- displacement); InSAR Line of Sights (time series); InSAR interferogram (spatial); etc. (3) different level of data processing: displacement, rate of displacement, InSAR Line of Sights (time series); InSAR interferogram, pressure source (pressure location and volume change), different processing method/technique, different reference, etc.

To improve the eruption forecasting and interpretation of unrest using deformation data it requires active participation from the community by sharing the data publicly, creating standard data processing procedures, archives with a consistent and common standard format including metadata. It will also require new ways to integrated the multiple types of deformation data and reduce the data dimension so that they can then be used and compared with other datasets such as seismicity or gas flux.

[1] Newhall et al (2017); https://doi.org/10.1016/j.jvolgeores.2017.08.003
[2] http://insarmaps.miami.edu/,
[3] https://comet.nerc.ac.uk/earth-observation/insar/how-insar-works/
[4] https://winsar.unavco.org/insar/