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Editorial: Multidisciplinary Investigations for Determining the Structure and Dynamics of Active Volcanic Systems

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Editorial on the Research Topic

Multidisciplinary Investigations for Determining the Structure and Dynamics of Active Volcanic Systems

Multidisciplinary investigations are widely considered by the scientific community to be the key strategy for understanding the interplay between magmatic processes and volcanic structures as a primary task for volcanological research.

Integrating geophysical, geochemical and geological datasets has the potential to provide accurate constraints on the characteristics of volcanic structures and their impact on magma storage and eruption. This Research Topic aims to provide a coherent selection of recent achievements in different aspects of volcanology, geophysics, petrology and/or geochemistry to provide new information about the structure and dynamics of active volcanic and magmatic systems.

The presented contributions include the application of laboratory to field-based experimental or modelling studies, geophysics methods and their development and integration post-inversion for the investigations of active volcanic areas.

Keller et al. present new bulk rock, glass and mineral analyses from Aso-4 eruption of the Aso caldera in Japan, dated at around 87 ka. The new data highlight the compositional diversity of the products, which the authors interpret as originating from a heterogeneous, mush-dominated upper crustal magma reservoir. This complex reservoir was reactivated by mafic recharge shortly before eruption, imparting an additional mixing signature to the deposits, consistent with other large silicic systems worldwide.

Di Luccio et al. analyse the seismicity of Lipari Island, in the context of the interaction between pre-existing structures and hydrothermal processes. Seismic events are detected by a dense array of stations using a Machine Learning approach. The temporal evolution of seismicity is tracked over the month and event locations are compared to known splay faults. The main finding is that seismic signals reflect the complex interaction between local tectonics, the hydrothermal system and sea wave activity. The results are also able to detect and discriminate transient signals likely associated with fault reactivation.

Unger Moreno et al. present the results of geologic and structural mapping from new multibeam sonar bathymetric data collected at Vesteris Seamount in the Greenland Basin. They combine these maps with visual observations from ROV dives and geochemical data to interpret the growth history and evolution of the seamount, with particular attention to its morphology and geologic structure. The study provides a robust base for more detailed geochemical and geochronological modelling in the future.

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Castro-Melgar et al. create two-dimensional spatial maps of the intrinsic and scattering attenuation in the Aeolian islands arc through seismic data generated from an active source experiment. The main findings of the study show that, in general, scattering dominates over intrinsic attenuation but that there are areas of higher intrinsic attenuation linked to sediments and isolated areas of higher scattering associated with the volcanic centres. The identification of such features facilitates geological interpretation, allowing separation of consolidated marine structures from independent subsurface volcanic elements. The results of the attenuation inversion will aid interpretation of volcano-tectonic relationships in the Aeolian region and provide a model for new research in similar regions around the world.

MacQueen et al. show how joint analysis of complementary geophysical methods can be used to evaluate volcanic subsurface structures. The authors present new gravity data for the Uturuncu Volcano in Bolivia and compare this with an existing resistivity model and with available geological, structural and geophysical datasets. This allows construction of a 3D model of the subsurface which suggests that recent unrest at Uturuncu is unlikely to be pre-eruptive. The study highlights the importance of integrating multiparameter studies to better understand the volcanic activity.

Iguchi et al. analyse a range of data on recent activity at Sakurajima volcano in Japan to explore the nature and dynamics of eruptive and non-eruptive deformation. By examining seismic data, infrasound generations and visual phenomena, the authors characterise eruptive deflation and non-eruptive deflation events. The latter primarily emit volcanic gas and their variations are related to the transition of magma from bubble-rich to bubble-poor conditions. The results help to discriminate the activity at a frequently active volcano based on geophysical data.

Males and Gottsmann have developed an integrated geodetic forward finite-element modelling of ground displacements and gravity changes from reservoir recharge at Erciyes Dağ, a high-prominence stratovolcano in Turkey. Inferring the mass and volume fluxes at the detectability limit of current common instruments, the study indicates that magma recharge at Erciyes Dağ may go undetected at fluxes sufficient to maintain an active reservoir containing eruptable magma as defined also for other volcanoes. The results of this study highlights the importance of having a monitoring system at Erciyes Dağ, including integrated geodetic and gravimetric techniques.

Corsaro et al. apply a multidisciplinary approach to investigate past eruptions of Etna Volcano, focussing particularly on three eruptions occurring in 1763 (Mt. Nuovo, Mt. Mezza Luna, and La Montagnola) for which the magmatic-tectonic interplay is poorly constraind. Their methods include the critical re-reading of historical chronicles, new fieldwork and sampling, petrologic study of the volcanic products, and integration of literature data. The results improve the stratigraphic record of historical eruptions at Etna Volcano, and modelling provides new insights into the sub-volcanic magmatic processes and volcano tectonics of the area. The multidisciplinary approach outlined in this paper could prove useful for other volcanoes whose past activity is still to be reconstructed.

We hope this Research Topic will be a reference for future research on active volcanic systems and will stimulate debate on key outstanding problems related to their structural setting, dynamics, monitoring and hazards.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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