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Editorial

Special Issue "Data Processing and Modeling on Volcanic and Seismic Areas"

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Volcanology, seismology and Earth Sciences in general, like all quantitative sciences, are increasingly dependent on the quantity and quality of data acquired. In recent decades, a marked evolution has characterized Earth sciences towards a greater use of analytical and numerical approaches, shifting these fields from the natural to the physical sciences.

Understanding the physical behavior of active volcanoes and faults is critical to assess the hazards affecting the population living close to active volcano and seismic areas, and thus to mitigate the risks posed by those threats [1,2]. The knowledge of a physical process requires the acquisition of a huge amount of information (data) on that particular phenomenon.

Today, different kinds of data record the processes that operate in volcanic and tectonic systems and provide insights that can lead to improved predictions of potential hazards, both immediate and long term. The geoscience community has collected an enormous wealth of data that require further analysis. The diversity and quantity of these geoscience data and collections continue to expand [3].

The increasing amount of data and the availability of new technologies and instrumentation at an ever-greater rate open new frontiers and challenges for acquiring, transmitting, archiving, processing and analyzing the newly available datasets. Guo [4] predicted growth for the general digital universe size of factor 10 from 2016 to 2025. Among all digital data, scientific data are those relevant to the observation of natural phenomena and characterized by non-repeatability, high uncertainty, high dimensionality and a high degree of computational complexity [4]. This means that scientific data need to be well preserved, due to the non-repeatability, and implies a parallel growth of processing capabilities to be well exploited. Cheng et al. [5] highlighted the striking growth of Earth Science data from molecular to astronomical scales and the increasing use of supercomputing tools for supporting geoscience research. The authors evidence how, with the continuously increasing availability of digital data, Earth Sciences are also turning from the traditional question-driven or problem-driven approach, where scientists seek to find answers to known questions, to the new data-driven one where scientists apply a data discovery process that might find answers to still unknown questions.

In agreement with Cheng et al. [5], we believe that new integrated multi-disciplinary knowledge systems and new data discovery techniques for handling and mining big data for knowledge discovery would spur the integration of transdisciplinary and multi-dimensional Earth science data. Furthermore, this will help the transition from a narrow focus on separate disciplines to a holistic, comprehensive and integrative focus of the different disciplines linked to the Earth Sciences.

With this aim, for this special issue titled "Data Processing and Modeling on Volcanic and Seismic Areas", we invited articles on all aspects of solid Earth Science that made use of data to analyze and model processes related to volcanoes or earthquakes.

Manuscripts with various types of analyses, including volcanic ground deformation modeling, seismic swarm characterization and volcanic gas measurement, have been proposed and published.

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The collection provides an insight into the enormous need for increasingly complex data analysis and modeling techniques to try to describe the natural phenomena here considered.

This special issue was introduced to collect the latest research on the processing and modeling of Earth Sciences data, and to address challenging problems with all topics related to volcanoes and seismic areas. Various subjects have been addressed in this collection, mainly on data processing for volcanic studies (three papers), tectonics (two papers) and one paper on data analysis of a new instrument to measure gases.

The first contribution to this collection [6] reports the results of the processing and combination of high-rate and low-rate geodetic data for revealing the dynamics underlying violent volcanic eruptions at Mount Etna. This study evidences the wide spectrum of ground deformation produced by these phenomena, to be investigated, processed and modeled in order to generate a picture of the feeding system of the volcano and better understand its dynamics and rates of magma transfer in the upper crust.

Another contribution focuses on volcanoes [7]: the authors exploit 20 years of high temporal resolution satellite Thermal Infra-Red (TIR) data collected over three active volcanoes (Etna, Shishaldin and Shinmoedake). They present the results of an analysis of this dataset performed through a preliminary RST (Robust Satellite Techniques) algorithm implementation to TIR data from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). This approach ensures efficient identification and mapping of volcanic thermal features even of a low intensity level, which is also useful in the perspective of an operational multi-satellite observing system.

The contribution by Woohyun Son et al. [8] proposes specific depth-domain data processing of migration velocity analysis (MVA) of seismic data collected during a survey on a saline aquifer sediment in the Southern Continental Shelf of Korea. This analysis allowed the authors to identify and determine the precise depth of a basalt flow that could act as a cap rock for CO_2 storage beneath the aquifer. The investigation, through the geological model obtained from both time- and depth-domain processing, provides suitable information for locating the best drilling sites for CO_2 injection, maximizing the storage volume.

In volcanic areas, gases represent important physical evidence of volcanic processes that need to be measured. Parracino et al. [9] have shown how novel range-resolved DIAL-Lidar (Differential Absorption Light Detection and Ranging) could herald a new era in the observation of long-term volcanic CO_2 gases.

An accurate and integrated analysis of different types of data such as GNSS, seismic and MT-InSAR, has led, in the work by Gatsios et al. [10], to a first account of deformation processes and their temporal evolution over recent years for Methana (Greece), thus providing initial information to feed into a volcano baseline hazard assessment and monitoring system.

Seismic data are among the most important data to understand the dynamics of the Earth's interior. A consistent analysis of a seismic swarm allowed Kostoglou et al. [11] to shed more light on the regional geodynamics of the Kefalonia Transform Fault Zone (Greece), and to follow the temporal evolution of the b-value to distinguish between foreshock and aftershock behaviors.

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