

Editorial

Multiplatform Remote Sensing Techniques for Active Tectonics, Seismotectonics, and Volcanic Hazard Assessment

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1. Introduction

In recent years, the continuous improvement of remote sensing technologies has profoundly strengthened our capacity to investigate the active deformation of the Earth's crust [1]. By combining data from different platforms—satellite, aerial, UAV, and ground-based—researchers have opened new perspectives for studying tectonic, seismotectonic, and volcanic processes [2,3]. These multiplatform approaches deliver multiscale, high-resolution information that allows researchers to monitor surface deformation, identify active faults, and assess volcanic and seismic hazards with unprecedented accuracy [4,5].

This Special Issue aimed to collect original research papers and case studies that integrate remote sensing techniques for the analysis of crustal dynamics, fault systems, and volcanic structures. The contributions highlight innovative methodologies and demonstrate how different sensing systems complement one another, thereby enhancing the quality and interpretation of geospatial data in active tectonic environments.

This Special Issue, “Multiplatform Remote Sensing Techniques for Active Tectonics, Seismotectonics, and Volcanic Hazard Assessment”, presents original research contributions that employ advanced remote sensing, geomatic, and geophysical methodologies—including GNSS, InSAR, LiDAR, DEMs, UAV photogrammetry, GIS, GPR, and magnetometry—to advance the understanding of active deformation, seismotectonics, and volcanic processes in diverse geological settings worldwide.

In total, this Special Issue features 11 high-quality papers, with first authors representing Spain, Italy, China, Greece, Iran, and Slovenia. Their co-authors are affiliated with institutions in Denmark, the Czech Republic, the United Kingdom, South Africa, Germany, and other countries, reflecting the international and collaborative nature of the research. The presented studies cover a wide range of regions across the globe, including La Palma, Canary Islands, Spain; the Central Apennines, Italy; Campi Flegrei, Italy; Croatia and Greece; the Preveza Region, Greece; Iran; South Africa; Mexico; China–Indonesia islands; South China; the Northeastern Tibetan Plateau; Changbaishan–Tianchi Volcano, Asia; and the Southern Alps, Slovenia. This broad geographic scope emphasizes the global relevance and applicability of remote sensing techniques for investigating active deformation, seismotectonics, and volcanic processes.



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2. An Overview of Published Articles

The papers collected in this Special Issue contribute to filling key gaps in the integration of remote sensing data for active tectonic and volcanic studies. By combining multiplatform observations with advanced analytical and modeling approaches, the studies demonstrate how modern techniques can enhance the detection and interpretation of crustal deformation, bridging the divide between surface observations and subsurface processes and supporting more reliable hazard assessment. The following overview summarizes the contributions of this Special Issue, arranged according to their chronological order of publication.

Occhipinti et al. (contribution 1) introduce Snap2DQuake, a Python-based implementation of the ESA SNAP platform for DInSAR analysis. Tested on recent earthquakes in Croatia and Greece, the tool simplifies interferometric processing and produces detailed deformation maps, supporting the broader use of open-source solutions in coseismic deformation studies. The findings highlight the importance of open-source DInSAR workflows as rapid, reliable tools that complement field observations in the early assessment of coseismic deformation.

Cui et al. (contribution 2) investigate satellite-derived carbon monoxide emissions associated with three major earthquakes occurring in different tectonic settings. The temporal and spatial analysis of CO anomalies provides evidence of gas emissions as potential precursory signals, contributing to the understanding of crustal degassing processes related to seismic activity. The findings highlight the potential of satellite-derived gas anomalies as useful precursory indicators, offering added value for understanding seismic processes and improving early-warning perspectives.

Jamšek Rupnik et al. (contribution 3) integrate lidar, photogrammetry, field mapping, and geophysical data to evaluate the late Quaternary activity of the Sava Fault (Slovenia). Subtle geomorphic and structural indicators, combined with OSL dating, indicate a slip rate of 1.8 ± 0.4 mm/yr over the last 27 ka, refining regional seismic hazard assessments for the Southern Alps. The findings highlight the importance of modern high-resolution remote sensing techniques and interdisciplinary approaches in detecting tectonic deformation in relatively low-strain rate environments with intense surface processes.

Wen et al. (contribution 4) apply the P-wave coda autocorrelation method to dense seismic array data from the Changbaishan–Tianchi volcano (China). Their analysis reveals complex crustal discontinuities, including magma conduits and low-velocity anomalies, which exert new constraints on the magmatic system and lithosphere–asthenosphere interactions beneath the volcano. The findings highlight the value of dense seismic-array coda autocorrelation methods for imaging deep crustal structures in volcanic settings, which result in new constraints on magmatic plumbing systems.

Ghari et al. (contribution 5) develop a cross-gradient joint inversion technique integrating DC resistivity and gravity gradient data to improve subsurface imaging. Applied to synthetic and real datasets from Iran and South Africa, the method yields more accurate resistivity and density models, demonstrating applicability for Geoscience, Heritage, and the Built Environment. The findings highlight the advantages of cross-gradient joint inversion for resolving complex subsurface architectures, delivering more robust models for multidisciplinary Geoscience applications.

Mercogliano et al. (contribution 6) propose an Independent Component Analysis (ICA)-based workflow to extract dominant thermal patterns from satellite Thermal Infrared (TIR) data over the Campi Flegrei caldera (Italy). This method isolates distinct thermal signatures related to volcanic and environmental processes, enhancing the interpretation of long-term surface temperature variations in restless calderas. The findings highlight the capability of ICA-based thermal analysis to disentangle overlapping volcanic and

environmental processes, offering a robust tool for long-term thermal monitoring of high-risk calderas. Niu et al. (contribution 7) present new geomorphological, photogrammetric, and radiocarbon data on the eastern segment of the Sunan–Qilian Fault in the Northeastern Tibetan Plateau. UAV-derived digital elevation models and trenching evidence indicate Holocene left-lateral activity with an estimated slip rate of 2.0 ± 0.3 mm/yr, suggesting a high potential for future large earthquakes in the fault zone. The findings highlight the effectiveness of UAV-derived geomorphic analyses for quantifying Holocene slip rates, thereby improving the assessment of seismic potential for remote active faults.

Basiou et al. (contribution 8) assess ground deformation and its impact on critical infrastructures in the Preveza region (Greece) using data from the European Ground Motion Service and multi-temporal InSAR analysis. The study quantifies vertical and horizontal displacement rates, highlighting vulnerable infrastructures and demonstrating the operational value of Copernicus services for regional hazard management. The findings highlight the operational relevance of Copernicus ground-motion datasets for identifying vulnerable infrastructures and supporting evidence-based mitigation strategies in tectonically active regions.

Yi et al. (contribution 9) analyze high-resolution seismic reflection data from the offshore segment of the Littoral Fault Zone (South China Sea) to investigate intraplate seismicity linked to graben dynamics. Their results reveal episodic normal faulting and gravitationally driven seismicity, offering new insights into the seismogenic behavior of coastal fault systems under compressional stress regimes. The findings highlight the need to reassess seismic and tsunami hazards along coastal intraplate fault systems, demonstrating the value of high-resolution seismic imaging for shallow crustal processes.

Battistelli et al. (contribution 10) investigate the morphotectonic and geomorphic expression of active deformation in the Central–Southern Apennines (Italy), an area where clear surface faulting evidence is scarce. Through an integrated analysis of topographic, aerial, and InSAR data, the authors identify a 20 km long corridor of diffuse deformation (the Castel di Sangro–Rionero Sannitico alignment), bridging the structural gap between adjacent fault systems and refining the understanding of active normal faulting in this sector of the Apennines. The findings highlight the added value of combining geological, geomorphic, and remote sensing datasets to identify diffuse deformation where clear surface faulting is absent, improving fault-system characterization.

Romero-Toribio et al. (contribution 11) present the first high-resolution drone-based aeromagnetic survey conducted over the Tajogaite volcano (La Palma, Canary Islands). This study provides a detailed three-dimensional magnetic susceptibility model revealing a shallow structure feeding the 2021 eruption and persistent high-temperature zones correlated with major fault systems, demonstrating the potential of UAV magnetometry in post-eruptive monitoring. The findings highlight the potential of drone-based aeromagnetic surveying to resolve shallow post-eruptive structures with unprecedented detail, enhancing monitoring of newly formed volcanic systems.

3. Conclusions

The articles published in this Special Issue collectively show how multiplatform remote sensing techniques are rapidly transforming the study of active tectonics, seismotectonics, and volcanic hazard assessment. The integration of UAV-based photogrammetry, satellite radar interferometry, thermal imaging, and geophysical inversion provides a quantitative understanding of crustal deformation processes at multiple spatial and temporal scales.

By combining advanced remote sensing methods with innovative methodologies for geological and geophysical analysis, the research community can now more effectively identify active structures, monitor ongoing deformation, and mitigate the risks associated

with seismic and volcanic activity. These multidisciplinary approaches sharpen the precision of geological interpretations and strengthen hazard assessment and risk mitigation in tectonically and volcanically active regions.

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We hope that the studies in this Special Issue will inspire the broader remote sensing community and encourage further research on the application of multiplatform remote sensing techniques for the analysis of active tectonics, seismotectonic, and volcanic hazard assessment.

Looking ahead, the integration of AI-based analysis, real-time monitoring systems, and high-resolution remote sensing promises to further advance the understanding of active deformation processes and their associated hazards.

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