

Special issue

Recent large-scale temporary passive seismic experiments in Europe: deployment and data quality

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Preface

Seismic monitoring infrastructures – in particular homogeneous broad-band seismic networks – are essential for understanding the structure, dynamics, and ongoing deformation of the Earth. Permanent seismic networks provide the backbone for monitoring seismicity, early warning, and rapid response. However, many scientific questions – especially those related to high-resolution imaging of the lithosphere-asthenosphere system, crustal anisotropy, and small-to-moderate earthquakes – require denser observational coverage than what is available through often inhomogeneous coverage by permanent installations alone. Temporary large-scale passive seismic experiments have therefore become a fundamental component of modern seismology. In recent decades, coordinated deployments such as EarthScope/USArray in the United States, and IberArray, AlpArray, and PACASE in Europe have demonstrated how a dense and homogeneous seismic broadband network, based on collaborative efforts, can produce significant advances in seismic monitoring, Earth imaging and geodynamic interpretation.

Specifically, the densely populated area around the Central Mediterranean and Adriatic Sea is highly susceptible to a variety of geohazards, including earthquakes, tsunamis, landslides, flooding and volcanic activity. The Adriatic Plate is consumed in a tectonically active belt spanning from Sicily, over the Apennines to the Alps, Dinarides and Hellenides, generating earthquakes up to magnitude 7. Characterizing the properties of plate boundaries, slabs, active faults and of the stress field is crucial for identifying the geodynamic factors driving plate deformation and associated geohazards. From 2022, the AdriaArray initiative is running a broadband seismic network designed to improve seismic monitoring and Earth imaging of the central Mediterranean region, a key area for understanding the interaction between the European plate and the Adriatic microplate.

This Special Issue presents a collection of contributions primarily linked to the AdriaArray Seismic Network deployment. The temporary component of AdriaArray results from the coordinated effort of European institutions, each contributing with equipment, expertise, and field personnel. The support of ORFEUS (Observatories and Research Facilities for European Seismology) and EPOS (European Plate Observing System) was crucial for the community. These joint efforts have enabled the installation and maintenance of a homogeneous network across several countries composed of 436 temporary and 1092 permanent stations, significantly improving seismic coverage in areas that were previously poorly monitored by broadband sensors (e.g., the easternmost regions). Besides the general description of the AdriaArray experiment, we collected a series of papers describing in detail every part of the AdriaArray Seismic Network, either defined regionally by countries of deployment, or encompassing more countries together when these were covered by a common mobile pool. Papers focused on data quality of the whole network as well as on visualization of wave propagation across AdriaArray complement the Special Issue.

In addition to AdriaArray contributions, this issue provides room for studies from other recent temporary experiments and permanent deployments. These include networks in the Netherlands and Malta, which supported seismicity studies; the DIVEnet, which focuses on monitoring the lower continental crust drilling activities for

the ICDP-DIVE project; the SEA-SEIS initiative in the North Atlantic, which has extended passive seismic monitoring offshore using ocean bottom seismometers, the upgrade of the permanent OTRIONS network contributing to monitoring the seismicity in Apulia, the large-N deployment ANTICS in Albania, and the freshly installed array around Santorini in the Aegean Sea. We also included an overview paper about the MOBNET stations used in passive experiments in the last three decades. Together, these different case studies underline the importance of temporary instrumentation for addressing regional tectonic problems in diverse geological settings – from sedimentary basins to active faults, volcanic structures, and offshore domains.

This Special Issue also represents an opportunity to acknowledge the important work carried out during field operations – from site selection and installation to long-term maintenance – which is often taken for granted despite being fundamental to the success of such large-scale passive seismic experiments. In addition to the scientific achievements, AdriaArray has contributed to strengthen cross-border cooperation and to community building by promoting shared practices for deployment, noise mitigation, archiving, and harmonized data quality assessment across Europe.

The articles collected in this volume describe various elements of temporary seismic monitoring, including network design, site selection strategies, installation practices in complex tectonic environments, and data access and management within European infrastructures. Data quality is also examined in almost all papers, for example through data completeness, noise spectra, detection threshold estimates, and evaluations of the general station performance. In addition to these topics, the papers also present first scientific results that demonstrate the value and potential of the newly acquired datasets: high-quality data directly affects the robustness of subsequent seismological analyses, from earthquake monitoring to tomographic modeling, receiver functions, and shear-wave splitting studies. Thanks to the temporary deployments, the minimum detected magnitude was significantly lowered in several regions.

This special issue provides an overview of the technical solutions, organizational challenges, and scientific opportunities associated with large-scale passive seismic deployments. We hope it will serve as a reference for ongoing and future projects, promoting an open scientific community, data sharing, and the continued development of innovative technical solutions in passive seismology.

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