ANDREA MORELLI – CURRICULUM VITAE

As a seismologist, my primary interest lies in the tomographic reconstruction of the Earth's deep structure. Throughout my career, however, two specific characteristics have defined my path. Firstly, scientific curiosity has led me to explore a **wide range of topics in seismology**, spanning from the inner core to the Earth's crust; from seismic noise to building resonance; and from very broadband seismometry to local microseismic networks. Secondly, I have consistently demonstrated a propensity for involvement in the **management of scientific infrastructures and projects**, for the collective benefit of the scientific community. While my career and visibility could perhaps have benefited from a more focused approach, curiosity and commitment to the community have been distinguishing features of my journey.

My most recent organizational and managerial commitment, which substantially occupied my attention from 2018 to 2023, was the establishment of my institution's organizational unit, the Center for Subsurface Monitoring (CMS), dedicated to monitoring the geophysical effects of **underground energy technologies**. Despite a formal institutional commitment to provide this service, the necessary resources were completely absent: personnel; hardware and software infrastructure; and funding. The unit was intended to rely solely on external funding, but the appropriate channel for such funding was nonexistent. Despite this challenge, I assembled a team of motivated scientists and engaged in negotiations to secure adequate financial resources, as well as the regulatory framework that would allow funding. Subsequently, we collaborated to construct a new monitoring infrastructure and implement an online routine (see [Morelli et al., 2024]). I ensured our active participation in five industrial areas, as mandated by the relevant ministry, and the unit concluded with a substantial budget surplus. My other contributions to the scientific community are summarized below.

Scientifically, my primary research areas encompass the study of **Earth's structure**, both deep and shallow, employing **body waves**, **surface waves**, **seismic noise polarization**, **correlation**, and **autocorrelation**; intermediate-magnitude **earthquake source** investigations; **numerical simulation** of seismic wave propagation for imaging and shaking scenarios; and fully **non-linear tomographic inversion**. A defining characteristic of my research lies in the original utilization of seismic signals in all their forms, from earthquake signals to marine microseisms, along with the development of requisite techniques. Notably, my studies of the **Earth's core** structure, as well as those of the **upper mantle** of the **Euro-Mediterranean** region and the geometry of **seismic sources** within the same geographical area, have had a profound impact on the scientific community. I have organized numerous advanced schools and imparted university courses in **Earth Physics**, **Seismic Tomography**, and **Inverse Problem Theory**. My salient scientific accomplishments are summarized below and are documented in my extensive publication list.

Current Position and Contacts:

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MAIN SCIENTIFIC RESULTS

My interest has led me to explore a wide range of topics. Here are some of the most significant results of my work.

Deep Earth Structure. During my years at Harvard University, from 1984 to 1987, I had the privilege of collaborating with an extraordinary group of seismologists, including Adam Dziewoński and John Woodhouse, among others. This period was pivotal in the development of global seismic tomography and the uncovering of significant discoveries within the Earth's interior. My primary contributions focused on the structural characterization of the Earth's core. Subsequently, I further contributed to influential publications that elucidated the then-novel and rapidly advancing technique of seismic tomography [Morelli and Dziewoński, 1987b; Morelli and Dziewoński, 1991; Morelli, 1993].

Upper Mantle and Mediterranean Geodynamics. During my years at ING in Rome, my interest focused on the European-Mediterranean domain and its intriguing geodynamics383838. With Claudia Piromallo, I studied earthquake localization and the upper mantle structure of this region using body wave propagation times and co-authored a model [Piromallo and Morelli, 2001; 2003] that provides a snapshot of the subducting lithosphere, used to draw geodynamic inferences [Faccenna et al., 2003] and still widely referenced today393939.

Seismic Sources in Italy and the Mediterranean. My interest in seismic sources began by observing the complex deformation of the active tectonic belt in the Mediterranean, comparing geodetic and seismic inferences[404040]. The 1997-98 Central Italy seismic sequence marked the beginning of a new collaboration with Göran Ekström on calculating seismic source characteristics through surface wave inversion[414141]. The European Mediterranean Regional Centroid Moment Tensor project, which emerged from that experience, benefited from the collaboration of Silvia Pondrelli, whose direct commitment then transformed it into a continuous activity and a systematically growing database[42].

Antarctica: Structure and Earthquakes. My research interests in Antarctica have included the deep structure of the continent [Danesi and Morelli, 2001; Morelli and Danesi, 2004; Danesi et al., 2007; Faccenna et al., 2008]; unusual earthquakes occurring beneath large glaciers [Danesi et al., 2007] and, more recently, crustal structure [Baranov et al., 2013; 2021a; 2021b].

Numerical Simulation of Seismic Wave Propagation: Apennines, Vrancea, shaking. The advancement of computing infrastructures and scientific software has enabled the numerical simulation of seismic wave propagation in realistic structures. This has facilitated the study of surface wave reflections employing the adjoint method [Stich and Morelli, 2007; Stich et al., 2009], the simulation of seismic wave propagation in three-dimensional media at various scales utilizing numerical techniques [Danecek et al., 2011], the application of full-waveform seismic tomography based on the adjoint method to investigate the slab structure beneath Vrancea [Baron and Morelli, 2017], and the synthesis of seismic shaking scenarios within the Po sedimentary plain [van Ede et al., 2020].

Seismic Noise: Generation and Use for Reconstructing Earth's Crustal Structure. In collaboration with Lucia Gualtieri and IPG Paris, I had the privilege of conducting research on the generation mechanisms of seismic background noise [Gualtieri et al., 2015a; 2015b]. A novel approach has been devised, enabling the determination of structural characteristics through the single-station observation of Rayleigh wave ellipticity on both seismic and background noise datasets [Berbellini et al., 2016; 2017; 2019; Jones et al., 2021; 2023].

Fully Non-linear Anisotropic Seismic Tomography. An ongoing collaboration with the University of Padua has produced anisotropic structure models following a fully non-linear and reversible-jump Markov chain Monte Carlo inversion method56.

MAIN CONTRIBUTIONS TO THE COMMUNITY, TRAINING, AND DEVELOPMENT OF OTHERS

Throughout my career, I have always been willing to actively participate in the management of large research infrastructures and scientific projects, for the collective benefit of the scientific community.

MEDNET. Upon accepting the offer to join the Istituto Nazionale di Geofisica in Rome as a researcher in 1987, I enthusiastically decided to return to Italy from the United States. I dedicated myself to new projects. In the late 1980s, with Domenico Giardini, we laid the foundations for the MEDNET broadband Mediterranean seismic network, which shortly after — when my colleague left — I directed alone for many years. At that time, MEDNET absorbed much of my energy, growing to include 12 stations—mostly in excellent but very remote sites in North African countries—and including another 6 stations in Italy from other projects. Giovanni Romeo, Alberto Delladio, and Salvatore Mazza—who replaced me as network director in 2000—made essential contributions to the endeavor. I participated in various bodies and committees of ORFEUS and the newly formed Federation of Digital Seismographic Networks.

Research Infrastructures in Antarctica. As a scientist engaged in global tomography and the development of seismographic networks, I promptly responded to the Italian research program in Antarctica by proposing the installation of a very-broadband station at the Base. This project, also conducted by Romeo and Delladio, has since significantly contributed to my extensive involvement in the Italian national Antarctic program and Antarctic research in general. Since 1993, I have coordinated, at the national level, the activities of all permanent geodetic and geophysical observatories. Furthermore, I have served as the national delegate to the SCAR Geosciences Standing Scientific Group and as a member of the SCAR ANTEC Expert Group (GoE).

The INGV Bologna Section. Since the early 2000s, I have strengthened my connection with the University of Bologna, which houses a substantial academic geophysics group. In 2003, I relocated to the city to establish a more conducive research environment and foster closer ties with the university and its students. During this period, I held the inaugural position of director of the newly established INGV Bologna Section, a group engaged in seismology, volcanology, oceanography, and climate research. In my capacity as director, I oversaw the establishment of an administrative center and the renovation of the premises located in Via Donato Creti.

TIDES-COST Network. From 2014 to 2018, I served as the coordinator of the COST Action TIDES (Time-DEpendent Seismology), a multinational network of scientists from 26 European countries. During this period, and earlier, I actively participated in numerous international scientific projects funded by the European Commission, including TRANSFER, NERIES, SPICE, and QUEST.

Monitoring of Underground Energy Technologies. My most recent managerial responsibility has been to establish an organizational unit dedicated to monitoring the geophysical effects of underground energy technologies (Center for Subsurface Monitoring, CMS). My institution had committed to this endeavor, but no tangible infrastructure yet existed: no personnel, no hardware or software infrastructure, and no funding of any kind. The unit was intended to rely solely on external funding, but the regulatory framework for this funding was itself lacking. Despite these challenges, I was able to assemble a team of highly motivated scientists and engaged in numerous negotiations to secure adequate financial resources, as well as a framework to facilitate funding. Subsequently, we collaborated to construct a new monitoring infrastructure and activated an online routine (refer to [Morelli et al., 2024]). I ensured our active participation in five industrial areas, as mandated by the relevant ministry, and the unit concluded with a substantial budget surplus.

Editorial and Reviewer Activities. I have conducted evaluations of proposals and funding requests for the European Research Council (ERC) and other international and national scientific funding agencies. I have participated in institutional evaluations by national agencies, such as the French National Research Agency (ANR) and the Italian Research Quality Assessment (VQR). Additionally, I served as the Editorial Board of the Geophysical Journal International from 2011 to 2025, overseeing the management of over 900 manuscripts. Furthermore, I have consistently served as a reviewer for manuscripts submitted to various scientific journals.

Contributions to the Development of Others and Training. Throughout my career, I have mentored several scientists at the commencement of their research endeavors, guiding them toward significant advancements in their respective fields. These include Claudia Piromallo, Silvia Pondrelli, Stefania Danesi, Irene Molinari, Lucia Gualtieri, and others. Additionally, I have spearheaded the organization of numerous postgraduate schools, including several courses at the International School of Geophysics in Erice (TP, Italy); four TIDES international schools in Bertinoro (Italy), Sesimbra (Portugal), Oxford (United Kingdom), and Prague (Czech Republic). Furthermore, I have provided lectures at other postgraduate institutions, such as the Mathematics for Signal Processing and Applications in Geophysics (MaSAG) program. In addition to these roles, I have served as an adjunct professor at the universities of Urbino and Bologna. Furthermore, I have been instrumental in supervising numerous university students for their master's and doctoral theses.

PROFESSIONAL HISTORY

Education. I graduated in Geology from the University of Bologna in 1981. Recognizing the need for a broader understanding of the sciences, I enrolled in and graduated in Physics in 1983, both degrees with honors. Subsequently, I pursued a doctoral program in Geophysics at the same university, where I obtained my PhD after three years of study.

Harvard. Under the guidance of my tutor, Enzo Boschi, I had the privilege of meeting Adam Dziewoński at summer schools. Our initial encounter occurred in Varenna in 1982, followed by another meeting in Erice in 1984. Adam extended an invitation for me to join Harvard University, where I served as a research associate for over two years. During my time at Harvard, I was fortunate to collaborate with an exceptional group of researchers, including John Woodhouse, in the seismology group. This period marked a pivotal era for global seismic tomography, leading to groundbreaking discoveries in the Earth's interior. My primary contributions focused on the structural composition of the Earth's core. Subsequently, I had the opportunity to contribute to significant publications that detailed the then-novel and rapidly evolving technique of seismic tomography.

Rome: MEDNET, Mediterranean structure and seismicity. In 1987, I enthusiastically accepted a researcher position at the Istituto Nazionale di Geofisica in Rome, which prompted my return to my home country. I continued collaborating with Adam on various projects, including the development of a global seismological reference model [Morelli and Dziewoński, 1993]. However, I also embarked on new initiatives. In the late 1980s, I collaborated with Domenico Giardini to establish the foundations of the MEDNET

broadband Mediterranean seismic network. Shortly after Giardini's departure, I assumed sole responsibility for MEDNET for many years. During this period, MEDNET garnered significant attention, expanding to include 12 stations primarily located in remote and exceptional sites, many in North African countries. Additionally, six stations in Italy from other projects were also integrated into MEDNET. Giovanni Romeo, Alberto Delladio, and Salvatore Mazza, who succeeded me as network director in 2000, made invaluable contributions to the initiative. I actively participated in various boards and committees of ORFEUS and the newly established Federation of Digital Seismographic Networks. During my tenure at ING in Rome, my focus shifted to the European-Mediterranean domain and its captivating geodynamics. In collaboration with Claudia Piromallo, I conducted research on earthquake location and the upper mantle structure of this region utilizing body wave travel times. We co-authored a model [Piromallo and Morelli, 2001; 2003] that provides a comprehensive snapshot of the subducting lithosphere. This model has been instrumental in drawing geodynamic inferences [Faccenna et al., 2003] and remains widely referenced today. My interest in seismic sources was initially piqued by observing the intricate deformation of the Mediterranean tectonic chain, comparing geodetic and seismic inferences. The 1997-98 Central Italy seismic sequence marked the commencement of a new collaboration with Göran Ekström, which enabled the retrieval of seismic source characteristics through the inversion of surface waves.

Antarctica. As a scientist engaged in global tomography and seismographic networks, when I heard about the Italian research program in Antarctica, I proposed the installation of an ultrabroadband station at the base[111]. The project, conceived by Romeo and Delladio, since 1990 has led to my long involvement in the Italian national Antarctic program and in Antarctic research in general[112]. Since 1993, I have coordinated, at the national level, the activities of permanent geodetic and geophysical observatories[113]. I have also been a national delegate to the SCAR Geosciences SSG and a member of the SCAR ANTEC GoE[114]. My research interests in Antarctica included the deep structure of the continent [115]; the unusual earthquakes that occur beneath large glaciers [116] and, more recently, the crustal structure[117].

Bologna: European projects and seismic noise. From the early 2000s, I intensified my involvement with the University of Bologna, which houses a substantial academic geophysics group. In 2003, I relocated to Bologna for a more conducive research environment and enhanced connections with the university and students. Between 2005 and 2013, I served as the inaugural director of the newly established INGV Bologna Section, a multidisciplinary group engaged in seismology, volcanology, oceanography, and climate research. Over time, my research group encompassed numerous young scientists with whom I collaborated on extensive studies of the European upper mantle. These included surface wave tomography [Schivardi and Morelli, 2009, 2011] and finite-difference travel-time tomography [Serretti and Morelli, 2011; Gualtieri et al., 2014]. Additionally, we imaged surface wave reflections through adjoint techniques [Stich and Morelli, 2007; Stich et al., 2009], and employed numerical techniques in 3D media to analyze seismic wave propagation at various scales [Danecek et al., 2011]. Among the prominent international collaborative projects funded by the European Commission in which I participated were SPICE, TRANSFER, NERIES, and QUEST. Notably, I coordinated the COST TIDES action. Subsequently, in collaboration with Irene Molinari and others, we shifted our focus to the structure of the crust. We compiled a comprehensive reference model for European crustal structure [Molinari and Morelli, 2011] and subsequently concentrated on Northern Italy [Molinari et al., 2015]. Furthermore, we incorporated ambient noise analysis into our research, whose generation mechanisms I had explored in collaboration with Lucia Gualtieri [Gualtieri et al., 2015a; 2015b]. A novel approach enabled the determination of the structure through single-station observation of Rayleigh wave ellipticity on seismic data and ambient noise [Berbellini et al., 2016; 2017; 2019]. I also used noise autocorrelation to study the reflectivity structure of the crust [Ashruf and Morelli, 2022]. Notably, we also conducted research on the normal modes of a historical tower in Bologna [Morelli et al., 2021].

Monitoring of Underground Energy Technologies. From 2018 to 2023, I coordinated the INGV Center for monitoring the effects of anthropogenic activities on the crust, such as deformations and potentially induced seismic phenomena, for which we set up a real-time supervised seismic analysis system that manages various local networks [Garcia et al., 2021; 2020; Braun et al., 2020; Morelli et al., 2024].

Teaching. Although not a prerequisite of my position within a research institute, I derive substantial satisfaction from teaching and interacting with students. During my time at the University of Urbino, I imparted the Geophysics (Earth Physics) course for two academic years. Subsequently, I taught the Seismic Tomography course and, subsequently, Geophysical Data Inversion, within the Master's degree program in Earth Physics at the University of Bologna. Furthermore, I provide tutoring services to undergraduate and graduate students for their master's and doctoral theses. Additionally, I have organized numerous workshops and international schools.

Bologna, June 14, 2025