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Preface to the volume "Geophysics for the future of the Planet"

This 26th volume collects a selection of papers presented during the annual national conference of the *Gruppo Nazionale di Geofisica della Terra Solida* (GNGTS) and published in the Bulletin of Geophysics and Oceanography [BGO, formerly *Bollettino di Geofisica Teorica ed Applicata* (BGTA)]. Overall, it summarises the papers presented at the conference, with particular focus on the novelties.

The GNGTS was established in 1978 as an offshoot of the Italian National Research Council (CNR) to promote, develop, and coordinate research in the field of solid Earth geophysics. The GNGTS comprised various sections: seismology, geodesy and gravimetry, geothermal research, crustal geophysics, mining and environmental geophysics, near-surface applications, as well as seismic exploration. In the past years, despite its limited budget, the GNGTS funded several research activities and sponsored multi-disciplinary projects, mainly dedicated to the study of the Earth's crust. About 500 researchers refer to the GNGTS and meet every year for a national conference: a point of reference in the life of Italian geophysics. Although the GNGTS institution was closed in December 2000, the GNGTS annual conference, sponsored by the National Institute of Oceanography and Applied Geophysics (OGS), continues to be held and reached its silver anniversary in 2006.

The GNGTS was governed by a committee composed of representatives from the CNR. In 2017, it changed its structure. A convention was underwritten by the legal representatives of the main entities that have always participated in the conference: the National Institute of Oceanography and Applied Geophysics (OGS), the National Research Council (CNR), the Department of Civil Protection (DPC), the ReLUIS Inter-University Consortium, the National Institute of Geophysics and Volcanology (INGV), and the Italian EAGE-SEG Section. Representatives of these bodies, then, take part in the work of the Scientific Technical Committee (STC). The OGS representative is the chairman of the STC. The STC governs the GNGTS, providing scientific and organisational guidance for the conference work and making key decisions on how to carry out tasks before and after the conference.

The GNGTS membership mailing list is also worth mentioning, with its more than 2,000 members. The GNGTS secretariat, which is based at the OGS, is responsible for disseminating key information regarding conferences, seminars, fellowships, and various other events that may be of interest to GNGTS members. This mailing list is a very powerful tool because it reaches almost every researcher and professor engaged in geophysics, seismology and, to some extent, volcanology.

The GNGTS annual conference, a recurring event for more than 40 years now (Table 1), is the spontaneous meeting point for all researchers who work, even in different roles, in geophysics, seismology, geology, and volcanology, as well as all the scientific branches that collaborate to improve our knowledge of the solid Earth. The participation in the GNGTS conferences has always been plentiful with more than 200 scientists, reaching the number of more than 600 in 1994, 2006, 2007, and 2019, when the conference location was Rome (Fig. 1). The GNGTS conference has always been about bringing scientists together and to encourage the geophysical scientific community to exchange ideas. The fundamental role of GNGTS as a "training ground for young scientists" should not be overlooked, and the GNGTS STC encourages the participation of young people in every way. It is often at GNGTS that young or aspiring researchers present their first work.

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Table 1 - Locations of the annual GNGTS national conferences.

Conference	Year(s)	Location	Organising institution
1-26	1981-2007	Rome	La Sapienza University, Rome
27-28	2008-2009	Trieste	OGS, Trieste
29	2010	Prato	Istituto Geofisico Toscano, Prato
30	2011	Trieste	OGS, Trieste
31	2012	Potenza	Basilicata University, Potenza
32	2013	Trieste	OGS, Trieste
33	2014	Bologna	Emilia Romagna Region, Bologna
34	2015	Trieste	OGS, Trieste
35	2016	Lecce	CNR, Lecce
36	2017	Trieste	OGS, Trieste
37	2018	Bologna	Emilia Romagna Region, Bologna
38	2019	Rome	CNR, Roma
39	2021	In streaming	OGS, Trieste
40	2022	Trieste	OGS, Trieste
41	2023	Bologna	Bologna University
42	2024	Ferrara	Ferrara University

The traditional and unusual free participation means that the conference is also open to all young PhD students, fellows, contract researchers and emerging researchers, who can participate in the conference by attending a scientific forum for the first time. Similarly, great attention is paid to the participation of the university component, both teachers and students, and for this reason the opportunity to attend a GNGTS conference in person is particularly important.

The COVID-19 pandemic, which started in Italy in February 2020, interrupted the organisation of the 2020 conference but it was decided not to give up on organising the successful yearly event in the future. For this reason, after the break in 2020, the 39th conference was held in streaming mode. Despite the absence of in-person participation, the 39th GNGTS conference still proved to be successful, and was, then, repeated and improved by the following edition organised in Trieste (Fig. 1b).

The nature of a free event for participants requires a significant financial commitment from the organisation coordinating the conference. Since the conference has been organised by the OGS, the availability of free facilities has always been sought. For many years the GNGTS was held at the CNR headquarters in Rome. In recent years, however, this location has become unavailable due to internal restructuring and, more recently, the minimum number of classrooms required to host the GNGTS is no longer available at the CNR headquarters. For these reasons, the STC of the GNGTS has been looking for suitable locations in a university environment.

The 41st GNGTS conference was held at the Belmeloro Campus of the University of Bologna from 7 to 9 February 2023, instead of November as in the past, with the possibility of holding the conference within university structures during the teaching holidays. Attendance at the conference was also facilitated by the central location of the city of Bologna, a hub for the whole of central and northern Italy [see more details in Rebez and Slejko (2024b)].

The 42nd GNGTS conference was held at the University of Ferrara from 13 to 16 February 2024. It should be remembered that for the organisation of the GNGTS, both in the preparation phase and during the event, the interest and collaboration of some professors of the host

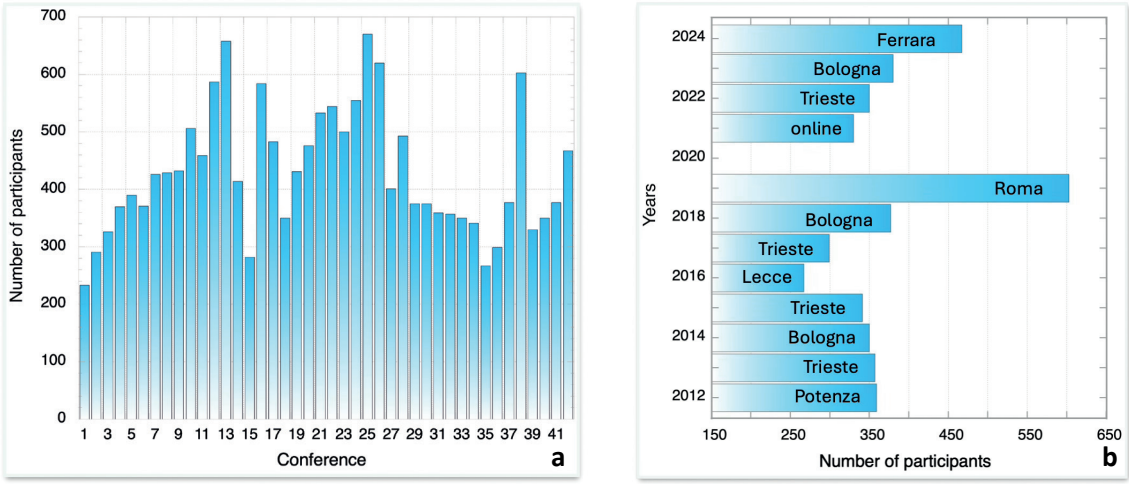

Fig. 1 – Number of participants at the GNGTS conferences: a) from the first to the last (42nd) edition; b) in the last editions (2012-2024), with related locations.

university, when the location is a university, plays a fundamental role. This role of "guest" was perfectly fulfilled by Riccardo Caputo, who strongly wanted to host the GNGTS at the University of Ferrara Campus and who worked hard for the organisational success of the event itself. For the type of conference that characterises the GNGTS, the location of the University of Ferrara Campus proved to be very suitable, in terms of space and logistics (Fig. 2). The geographical position of the city of Ferrara is very central and easily accessible from the main Italian cities. It should also be noted that the areas available for the poster sessions were particularly large, which is not always easy to achieve in other venues (Fig. 3).

Fig. 2 - The location of the 2024 GNGTS conference.

Fig. 3 - The poster session at the 2024 GNGTS conference.

The total number of participants was 467 and the percentage of women was 38.7% (Table 2 and Figs. 4 and 5).

Table 2 - Participation in the 42nd GNGTS conference.

Total number of participants	467
University	198
National Institute of Geophysics and Volcanology - INGV	155
National Institute of Oceanography and Applied Geophysics - OGS	37
National Research Council - CNR	34
Others	43

With regard to the organisation of the conference and its potential impact on the environment, solutions were gradually introduced to reduce waste and limit the environmental footprint. Water bottles were not distributed, instead all participants were asked to bring their own to reduce the environmental impact. The use of paper was kept to a minimum and the conference programme was not printed but made available on the GNGTS website, accessible via computer or smartphone. At the end of the conference, all lanyards were collected and sanitised for future use the following year.

Fig. 4 - Audience during a session.

Fig. 5 - The chairman desk.

A fundamental part of the creation of the GNGTS is the website, where all the information was available before and during the conference. The GNGTS website was also used as a repository for the proceedings of the last GNGTS conference (https://gngts.ogs.it).

The 42nd GNGTS conference was organised considering three main topics, each collecting three different subjects, scheduled as nine sessions (Table 3). The first topic referred to basic geodynamics and seismology, the second to risk assessments, and the third to applied geophysics. All key information and abstracts were written in English to facilitate understanding and participation by international researchers and students.

Table 3 - Topics of the 42nd GNGTS conference and titles of the sessions.

Sess.	Title	Convenors
Topic 1 - SEISMICITY, VOLCANOES, DATA AND MODELS		
1.1	Recent advances in the study of earthquakes, faults and seismogenic processes in natural and experimental faults	Paolo Galli (DPC) Massimo Cocco (INGV) Luisa Valoroso (INGV)
1.2	Volcanoes and geothermal fields	Mimmo Palano (INGV) Francesca Forni (UniMI)
1.3	Physical models for the Solid Earth and integration between modelling and data of different nature	Anna Maria Marotta (UniMI) Carla Braitenberg (UniTS) Barbara Orecchio (UniME)
Topic 2 - DISASTER RISK ANALYSIS AND REDUCTION		
2.1	Earthquake and tsunami hazard: different return periods, different conceptual schemes and models in a continuum spectrum of time	Daniela Di Bucci (DPC) Dario Albarello (UniSI) Bruno Pace (UniCH)
2.2	Science and technology to support earthquake prevention and preparedness	Mauro Dolce (UniNA) Sara Sgobba (INGV) Maria Polese (UniNA)
2.3	Risk communication	Serena Tagliacozzo (IRPPS CNR) Valentina Rizzoli (Sapienza UniROMA)
Topic 3 - APPLIED GEOPHYSICS FOR ENERGY, ENVIRONMENT AND NEW TECHNOLOGIES		
3.1	Energy transition and resources	Vincenzo Lipari (OGS) Paolo Mazzuchelli (ARESYS) Erika Barison (OGS)
3.2	Near surface geophysics	Emanuele Forte (UniTS) Chiara Colombero (PoliTO) Michele Cercato (Sapienza UniROMA)
3.3	Theoretical and methodological development in Applied Geophysics	Andrea Tognarelli (UniPI) Luca Masnaghetti (SLB) Gianluca Fiandaca (UniMI)

The number of communications presented, as oral or poster, at the different sessions was in total 279 and they differed according to the relevance of the subjects treated (Table 4). Session 1.1 on earthquakes and faults was (as also in the past) largely the theme of most interest with 79 notes, the session 2.2 on earthquake prevention and preparedness was the most populated of Topic 2, with 34 notes, while session 3.2 on near surface geophysics had the largest participation in Topic 3, with 34 notes.

A noteworthy mention goes to the Licio Cernobori Geophysical Association, which, once again this year, chose the GNGTS conference as the venue for the award ceremony in memory of a dear colleague and friend who passed away prematurely many years ago (Fig. 6).

Peer-reviewed proceedings of the national conferences have been published in special volumes and on CD-ROMs, mainly in Italian, since 1997. These documents are also available at the GNGTS website (https://gngts.ogs.it). Since the year 2000, with the exceptions of years from 2012 to 2015, when the volumes of the proceedings of the conference were printed, it was decided to publish selected papers from the GNGTS conferences in an international geophysical journal (the BGTA, now BGO), also in order to achieve a broader dissemination of the GNGTS activities for an international audience.

Table 4 - Number of oral notes and posters for the various sessions.

Session	Oral	Poster	Total
1.1	54	25	79
1.2	22	9	31
1.3	19	7	26
			136
2.1	23	3	26
2.2	29	5	34
2.3	13	1	14
			74
3.1	12	6	18
3.2	23	11	34
3.3	17	0	17
			69
	212	67	279

Fig. 6 - Award ceremony of the Licio Cernobori Geophysical Association.

Over the years, multidisciplinary and single-theme volumes have been issued (Table 5). The multidisciplinary volumes, which make up most of the published volumes, generally presented one paper from each of the sessions of the GNGTS conference. In this case, all three broad themes, i.e. Geodynamics, Seismic characterisation of the territory, and Applied geophysics, have been documented by a set of papers. Conversely, the six thematic issues published to this day presented papers from a single GNGTS session that was of particular interest in the year of presentation. In this way, one BGTA volume presented studies on seismic hazard in Italy (Marcellini *et al.*, 2004), another volume was dedicated to the 2009 L'Aquila earthquake (Amato *et al.*, 2011), another to the GNGTS session concerning earthquake forecasting and hazard

assessment (Albarello and Meletti, 2012), a fourth to the international session on the seismic hazard of the critical facilities (Grimaz and Slejko, 2014), a fifth referred to the session about science, technology, and communication to support seismic prevention (Dolce and Martelli, 2019), and a sixth focused on energy, related risks, and cascade effects (Martelli and Masi, 2021). A summary of the GNGTS structure and activities is described in a recent paper by Slejko (2020).

The present volume consists of six of the 279 papers presented, orally or as posters, during the 42nd GNGTS national conference. The topics treated in this volume represent, more or less, all subjects of the conference and cover several themes of solid Earth geophysics, such as seismology, seismic risk, risk communication, and exploration geophysics. These topics present specific studies conducted in the Italian territory that also give important insights into the subsurface geological/geophysical structure and on the role of surficial geology in seismic risk assessment.

Table 5 - The special issues of the BGTA dedicated to selected papers from the GNGTS conferences.

No.	Conference - year	Editor(s) (year)	Title	BGTA vol./issue
1	19-2000	Slejko (2002a)	Advances in Solid Earth geophysics	43/1-2
2	20-2001	Slejko (2002b)	More about Solid Earth Geophysics	43/3-4
3	21-2002	Marcellini *et al.* (2004)	More about regional and local seismic hazard in Italy	45/4
4	22-2003	Slejko and Rebez (2005)	A step forward in Solid Earth Geophysics	46/2-3
5	23-2004	Slejko and Rebez (2006)	New insights into Solid Earth Geophysics	47/1-2
6	24-2005	Slejko (2007)	Solid Earth Geophysics: a bit of this and a bit of that	48/2
7	25-2006	Slejko (2008)	Carlo Morelli's mission and passion: Geophysics	49/2
8	26-2007	Slejko (2009)	Pieces of Geophysics	50/2
9	27-2008	Slejko (2010)	Novelties in Geophysics	51/2-3
10	28-2009	Albarello and Slejko (2011a)	Geophysical research in Italy	52/2
11	28-2009	Amato *et al.* (2011)	The 2009 L'Aquila earthquake: geophysical insights from the 28th GNGTS Congress	52/3
12	28-2009	Albarello and Slejko (2011b)	Geophysics for prospecting, monitoring, and hazard assessment	52/4
13	28-2009	Albarello and Meletti (2012)	Earthquake forecasting and hazard assessment	53/1
14	29-2010	Cardarelli and Slejko (2012)	A little bit of Geophysics	53/3
15	29-2010	Rossi and Slejko (2012)	The Earth, its phenomena, and some related methods	53/4
16	30-2011	Grimaz and Slejko (2014)	Geophysics and critical facilities	55/1
17	35-2016	Persico and Slejko (2017)	Recent multi-topic geophysical investigations	58/4
18	36-2017	Dolce and Martelli (2019)	Science, technology and communication to support seismic prevention	60/2
19	36-2017	Rossi and Slejko (2020)	Geophysical solutions in environmental and natural hazard fields	61/1
20	37-2018	Volpi and Slejko (2020)	Geophysical approaches for subsurface investigation: Italian case studies	61/3
21	37/38-2018/2019	Martelli and Masi (2021)	Energy, related risks and cascade effects	62/2
22	38-2019	Rebez and Slejko (2021)	One small step to further our knowledge of the solid Earth	62/4
23	39-2021	Rebez and Slejko (2022)	Italian Geophysics today	63/4
24	40-2022	Rebez and Slejko (2023)	Exploring the solid Earth: novel geophysics and seismology	64/4
25	41-2023	Rebez and Slejko (2024a)	Improving Geophysics for a better future	65/2

The first paper of this volume is by Faoro *et al.* (2025) and describes a revision of the seismicity of the Ferrara (NE Italy) area for the period prior to A.D. 1500. Eleven earthquakes dated from 1234 to 1495 and reported in the Italian catalogue were re-evaluated. The evidence available was critically analysed and placed in its proper historical context. The conclusions show that some earthquakes were overestimated, while others appear to be non-existent and should be deleted from the catalogue.

An unknown later seismic phase, called the x-phase, has been found on intermediate-depth waveforms and deep earthquakes of the southern Tyrrhenian subduction system. The possible presence of a similar later arrival after the S waves, which may add more information about the origin of the waves, is investigated by Ninivaggi *et al.* (2025) in the second paper of this volume, where previous findings and new analyses on S waves are presented.

The paper by Varchetta *et al.* (2025) introduces the Seismic Data Quality (SDQ) project, an open-source Python tool package designed to evaluate the performance of co-located accelerometric and velocimetric stations, assess data quality, and support technicians in the seismic surveillance room. The SDQ tool was tested using data from 200 stations of the INGV, analysing over 15,000 waveforms from Italian earthquakes with magnitude larger than, or equal to, 3.5 and hypocentral distances less than, or equal to, 150 km, recorded from 2012 to 2023.

The paper by Zidarich *et al.* (2025) presents initial findings from the analysis of seismic risk perception, focusing specifically on the vulnerability of non-structural elements in the hospitals of Lecce and Caserta (southern Italy). The study relies on qualitative content analysis within a grounded theory framework to explore discussions on seismic risk centred on regulatory/legal and scientific aspects, and emphasising the roles of medical staff during earthquakes, patient safety concerns, and the need for clearer protocols.

Seismic risk communication (SRC) is a crucial element of disaster risk management, vital for enhancing awareness and fostering preparedness. The fifth paper of the present volume (Saraò *et al.*, 2025) builds on insights from a scoping review of SRC in Europe from 2000 to 2022 and highlights the evolution of approaches, tools, and models, confirming the surge in interest since 2000. The review of 109 papers shows that only 48 evaluated the effectiveness of communication strategies. Those that did primarily employed quantitative methods, such as surveys, while qualitative approaches were underused. Critical factors like recipient understanding of seismic vulnerability and the credibility of information sources were often overlooked.

The geophysical characterisation of the subsurface in areas affected by strong earthquakes is a fundamental practice, which enables the correct assessment of seismic hazard and risk. The final paper of this volume (Böhm *et al.*, 2025) considers the area of the historical centre of Arquata del Tronto (central Apennines, Italy), which was destroyed by a strong earthquake in 2016. A three dimensional P-wave and S-wave velocity model was defined and the model was obtained from first arrival tomography. The results identify some anisotropic features present in the area due to the existence of flysch formations characterised by the alternation of sandstone, pelite, and marl, in different proportions.

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