

## **Preface to the volume “Exploring the solid Earth: novel geophysics and seismology”**

This is the twenty-fourth volume collecting a group of selected papers presented during the annual national conference of the Gruppo Nazionale di Geofisica della Terra Solida (NGGTS), published in the Bulletin of Geophysics and Oceanography [BGO, formerly Bollettino di Geofisica Teorica ed Applicata (BGTA)]. Overall, it summarises the work presented at the congress, with particular focus on the novelties.

NGGTS 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. NGGTS 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, NGGTS funded several research activities and sponsored multi-disciplinary projects, mainly devoted to the study of the Earth’s crust. About 500 researchers refer to the NGGTS and meet every year for a national assembly: a point of reference in the life of the Italian geophysics. Although the institution NGGTS was closed in December 2000, the NGGTS annual conference, sponsored by the National Institute of Oceanography and Applied Geophysics (OGS), continued to be held regularly.

The NGGTS annual conference, a recurring event for 40 years now (Table 1), is the spontaneous meeting point for all researchers who work, even with 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 Covid pandemic, which started in Italy in February 2020, interrupted arranging the 2020 conference but it was decided not to give up on organising the successful yearly event. For this reason, after the break in 2020, the 39<sup>th</sup> conference was organised in streaming mode. Despite the absence of participation in person, the 39<sup>th</sup> NGGTS conference still proved successful.

The 2022 Conference was designed to help the entire NGGTS scientific community in responding to the pandemic. As soon as the pandemic eased, the conference, which had been organised online in the previous edition, was organised in person. It was a relief for everyone to participate in the typical NGGTS presentations and discussions. It was also good to see friends and colleagues in person. NGGTS has always aimed at bringing scientists together and encouraging the geophysical scientific community to exchange ideas. The 40<sup>th</sup> conference was also honoured by having the Head of the Civil Defence Department, Renato Curcio, attending the General Assembly, where he pointed out that many of the topics discussed and the studies presented are related to preventing natural disasters, one of the main objectives of the Civil Protection (Figs. 1 and 2). The setting of Trieste as the venue for the conference was magnificent on its unusual summer date, with the sea illuminating the hall and the poster area.

The fundamental role of NGGTS in its function as a ‘training ground for young researchers’ should not be overlooked and the NGGTS Scientific Committee encourages the participation of young people in every way. Often, it is precisely at the NGGTS that young or aspiring researchers present their first work. The traditional and anomalous free participation means that the conference is also open to all young doctoral students, fellows, contract, and aspiring researchers, who can participate in the conference by attending a scientific forum for the first time. Similarly, there is a great deal of attention to the participation of the university component of both teachers and students and for this reason, the possibility of attending a NGGTS conference in person is particularly important.



Fig. 1 - Informal meeting among the GNGTS director, Alessandro Rebez, the OGS President, Nicola Casagli, the Head of the Civil Defence Department, Renato Curcio, and the Vice Mayor of the Trieste Municipality, Serena Tonel.



Fig. 2 - The General Assembly during the 40<sup>th</sup> GNGTS conference.

During the general convention meeting, specific topics of general interest for the geophysical community are discussed and new activities are presented. The prizes of the Licio Cernobori Association for Geophysics (AGLC) are also assigned. The AGLC, established on 30 October 2000 in remembrance of Licio Cernobori, a geophysicist who sadly died prematurely, aims at promoting geophysical studies, and above all the scientific training and the development of young researchers. This objective was initially pursued through the awarding of a study prize at the University of Trieste, also open to undergraduates/graduates in applied geophysics of other universities or scientific structures involved in joint projects with the University of Trieste. Since 2010, the AGLC has followed the tradition of assigning the prize to young speakers at the annual GNGTS congress, and the winners are announced and awarded during the General Assembly. Since 2012, three prizes have been awarded to young researchers working in three main themes of GNGTS, which at the 40<sup>th</sup> congress were: Geodynamics, Seismic characterisation of the territory, and Applied geophysics.

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
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	Roma	CNR, Roma
39	2021	In streaming	OGS, Trieste
40	2022	Trieste	OGS, Trieste

Peer-reviewed proceedings of the national conferences have been published since 1997 in special volumes and on CD-ROMs, mainly in Italian. These documents are also available at the GNGTS website <https://gngts.ogs.it>. Since the year 2000, with the exceptions of 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.

Over the years, multidisciplinary and single-theme volumes have been issued (Table 2). 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 suite of papers. Conversely, the five thematic issues published up to now, have presented papers from a single GNGTS session that was of particular interest in the year of presentation. In this way, one BGTA volume was devoted to the 2009 L'Aquila earthquake (Amato

*et al.*, 2011), another to the GNGTS session concerning earthquake forecasting and hazard assessment (Albarelo and Meletti, 2012), a third to the international session on the seismic hazard of the critical facilities (Grimaz and Slejko, 2014), a fourth referred to the session about science, technology, and communication to support seismic prevention (Dolce and Martelli, 2019), and a fifth focused on energy, related risks, and cascade effects (Martelli and Masi, 2021). A summary of the structure and activities of the GNGTS is described in a recent paper by Slejko (2020).

The present volume consists of 7 of the 156 papers presented orally or as posters during the 40<sup>th</sup> GNGTS national conference, held in Trieste in June 2022. The topics treated in this volume cover several themes of solid Earth geophysics, such as seismology, exploration geophysics, and engineering seismology. They 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 2 - The special issues of 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 <i>et al.</i> (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	Albarelo and Slejko (2011a)	Geophysical research in Italy	52/2
11	28-2009	Amato <i>et al.</i> (2011)	The 2009 L'Aquila earthquake: geophysical insights from the 28th GNGTS Congress	52/3
12	28-2009	Albarelo and Slejko (2011b)	Geophysics for prospecting, monitoring, and hazard assessment	52/4
13	28-2009	Albarelo 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

The purpose of the first paper of this volume (Capponi *et al.*, 2023) is to exploit all data sets retrievable in literature (maps, seismic profiles, or scattered data) that refer to the characteristics and principal features of the crust of various parts of the Mediterranean Sea area and combine them in a full 3D model of the principal geological horizons covering the whole region, completed by the density and magnetic susceptibility distribution.

An alternative explanation for the origin of the buried mounds in the southern Roosevelt sub-basin of the eastern Ross Sea, Antarctica, as mud volcanoes, is formulated in the paper by Barro Savonuzzi *et al.* (2023) on the basis of seismic reflection profile reprocessing and comparison with other, better studied, mound provinces in the Ross Sea.

The third paper (Valentini *et al.*, 2023) proposes a new methodological approach to studying fault interaction within the framework of a seismic cycle, considering all the destructive earthquakes ( $M_w > 6.0$ ) that occurred in the last thousand years in the central Apennine fault system and modelling faults with a more complex geometry characterised by an elliptical outline, which better describes the actual shape of a fault at depth.

The study by Milano *et al.* (2023) presents a procedure in the time domain to directly compare the waveforms of teleseismic events recorded by seismic stations located a few kilometres from each other and equipped with different instrumentations. The method has been tested on teleseismic events recorded by the seismic stations located in and close to the Mefite d'Ansanto area (southern Apennines, Italy), which represents the largest non-volcanic low temperature CO<sub>2</sub> emission area on Earth.

The advantages of non-ergodic modelling of the ground motion to map the regional characteristics of source and propagation effects in Italy are investigated in the fifth paper by Brunelli *et al.* (2023). The study shows areas (northern Italy and southern Ionian Sea) where the motion was significantly different from that predicted by a reference model, and in particular was underestimated.

Iurcev and Pettenati (2023) show the different steps leading to an analytical approach to evaluate the uncertainties of the Sibson interpolation method (Natural Neighbour). After a series of tests with a synthetic data set and a surface with a known differentiable function, the authors show an example using the data set of accelerometric recording from the  $M$  6.5 Norcia earthquake of 30 October 2016.

In the last paper of the present volume, Tarantino *et al.* (2023) propose a new data inversion tool, based on a probabilistic Bayesian approach, capable of scanning near-surface magnetised structures. The authors have validated the algorithm on synthetic magnetic data generated by anthropogenic-like bodies, and have, then, inverted experimental magnetic measurements acquired at the archaeological site of Phaistos (Crete, Greece). Their retrieved most-likely model fits well with the remains found in the study area, and correctly identifies the magnetic susceptibility contrast, thickness, and depth of the Minoan wall top brought to light by the archaeological excavation.

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