

Vol. 49 – N. 2

June 2008

# **Bollettino di Geofisica**

teorica ed applicata

*An International Journal of Earth Sciences*

Guest Editor: D. Slejko

## **Carlo Morelli's Mission and Passion: Geophysics**

Selected papers from the 25<sup>th</sup> Annual Conference  
of the Italian Group for Solid Earth Geophysics

Rome, November 28-30, 2006



Istituto Nazionale di Oceanografia  
e di Geofisica Sperimentale

ISSN 0006-6729

*Responsibility for all statements made in B.G.T.A. lies with the authors*

Cover design and typesetting: Nino Bon – OGS  
Printing: Mosetti – Trieste  
Authorized by the Tribunale di Trieste, n. 242, September 17, 1960

## Preface

This volume should have represented a prosperous moment in the life of the “Gruppo Nazionale di Geofisica della Terra Solida” (GNGTS) because, although the institution closed in December 2000, the annual conference continued to be held reaching its silver anniversary in 2006. On the contrary, one year later, during the 26<sup>th</sup> conference, the GNGTS first and only president, prof. Carlo Morelli, had an accident and some months later he passed away. This volume, then, is dedicated to him, he who was one of the founders of the GNGTS, for which he had worked for the last 27 years. The GNGTS is devoted to solid Earth geophysics, has sponsored projects in the past, and now presents the state of the art in geophysical studies during the annual conference. Prof. Carlo Morelli spent his life sponsoring and developing geophysical projects and was curious and sensitive to geophysical innovations throughout his long life. The GNGTS and prof. Carlo Morelli were thus closely linked or, better, we can say that the GNGTS is a creation of prof. Carlo Morelli.

The GNGTS was established in 1978 as a coordination group of the Italian “Consiglio Nazionale delle Ricerche” to promote, develop, and coordinate research in the field of solid Earth geophysics. The GNGTS is divided into various sections: seismology, geodesy and gravimetry, geothermy, crustal geophysics, mining and environmental geophysics, and seismic exploration. In these past years, in spite of its limited budget, the GNGTS has financed several research activities and has sponsored multi-disciplinary projects, mainly devoted to the study of the Earth’s crust. About 500 researchers refer to the GNGTS and meet every autumn for a national assembly: a reference point for the life of Italian geophysics. The peer-reviewed proceedings of the national conferences have been published, mainly in Italian, in special volumes, and in CD-Roms since 1997. These last documents are also available at the GNGTS web site ([www2.ogs.trieste.it/gngts](http://www2.ogs.trieste.it/gngts)). Recently, it has been decided to publish selected papers from these conferences, in an international geophysical journal, for a better dissemination of information about GNGTS activities with a view to an international audience.

This volume represents the seventh one of its kind and consists of nine papers out of 265 presented during the 25<sup>th</sup> GNGTS national conference, which was held in Rome in November 2006. The topics treated in this volume cover several themes of solid Earth geophysics, such as seismology, exploration geophysics, and applied geophysics.

Going into detail, Stramondo provides a basic overview of the theory and applications of SAR interferometry. Argnani *et al.* report the results of a multichannel seismic survey aimed at studying some tectonic features located offshore Sicily. Galli

and Naso investigate the causes of the distribution of seismic shaking produced by the 1743 earthquake by means of an integrated geological, geotechnical, and geophysical analysis. Bozzano *et al.* report on the seismic survey as well as the seismometric measurements carried out in order to define the engineering-geology model and the elastic properties of the seismically-induced Cerda landslide, in Sicily. Sandron *et al.* use a kinematic approach to compute ground shaking scenarios of three earthquakes: the Bovec 2004 event and two quakes which occurred in Iceland in 2000. Pre-processing algorithms that help highlight the characteristics of the signal recorded before the application of the H/V spectral ratio are summarized in the paper by Carniel *et al.*. Bernasconi investigates some aspects of multicomponent processing in seismic while drilling acquisitions. Cardarelli analyses the properties and characteristics of some seismic inversion algorithms. In the last paper of the volume, Godio analyses the performances of standard radar systems for snowpack characterization.

I wish to thank Dario Albarello, Walter Böhm, Riccardo Caputo, Francesca Romana Cinti, Paolo Galli, Marco Mucciarelli, Michele Pipan, Gaetano Ranieri, Antonio Rovelli, Fabio Sabetta, Luigi Sambuelli, Stefano Solarino, Umberta Tinivella, and Gianluca Valensise, who participated in the selection and reviewing process of the papers. Special thanks are due to Rinaldo Nicolich, who cooperated in the preparation of the reminiscences about prof. Morelli, and to Carlo Doglioni, who supplied some of the pictures of prof. Morelli.

*Dario Slejko*

Istituto Nazionale di Oceanografia  
e di Geofisica Sperimentale

## CARLO MORELLI (1917-2007)

Carlo Morelli was born in Trieste on October 10, 1917. He studied in Pisa at the Regia Scuola Normale Superiore where he obtained a degree in Mathematics and Physics in 1940 and got a university teaching qualification in Earth Physics in 1948.

He was seismology assistant at the Trieste Seismic Station (1943), assistant professor of Mathematics, Topography and Earth Physics at the University of Trieste and at the University of Padova (1944-1953). He was a founding member of the Engineering Faculty of the University of Trieste. From 1953 he was at the University of Bari, where he taught Geodesy and founded the Istituto di Geodesia e Geofisica. He became full professor of Earth Physics in Bari in 1956 and dean of the faculty of Science in 1962. He returned to the University of Trieste in 1963, to take on the position of professor of Applied Geophysics, where he founded the Istituto di Miniere e Geofisica Applicata and, since 1993, he was acknowledged as Professor Emeritus. In 1949 he founded the Osservatorio Geofisico Sperimentale (OGS) in Trieste and was its director until 1963 and its president until 1975.

He was among the founding members of the European Seismological Commission (ESC) of IASPEI (president from 1986 to 1990), European Association of Exploration Geophysicists (EAEG) (president from 1962 to 1963), and European Geophysical Society (president from 1973 to 1976).

He served as president also in the International Gravity Commission (IGC) of the International Association of Geodesy (IAG) from 1967 to 1983, and as vice-president of the UNESCO-Intergovernmental Oceanographic Commission (IOC) from 1970 to 1972.

From 1971 to his death he was member of the Editorial Board for the International Bathymetric Chart of the Mediterranean (IBCM) and Vice-Chairman of the Consultation Group for Ocean Mapping (CGOM) of IOC. From 1978 to his death he was president of the Italian Group for Geophysics of the Solid Earth (GNGTS), and of the CNR's Italian Oceanographic Commission.

He was member of the Accademia Nazionale dei Lincei (correspondent since 1946, national since 1990), of the Istituto Veneto di Scienze, Lettere ed Arti (correspondent since 1967, effective since 1992) and member of several foreign geophysical and geodetic societies. He was among the founding members of the Academia Europaea (Cambridge, 1988).



Among his distinctions, the “Mauro Baratta” Prize of the Regia Accademia d’Italia (1941), the Golden Medal for Culture and Arts of the Italian Minister of Education (1975), the “Emil Wieckert” Medal of the German Geophysical Society (1988), the Scientific–Technical Prize and Honorary Membership of the Associazione Mineraria Subalpina, Torino (1990), the Laurea “Honoris Causa” in Geological Sciences from the University of Padova (2004).

Carlo Morelli achieved many scientific goals. The biggest part of his experimental research is pertinent to Gravimetry. He studied the new gravity-meters, the pendulums and the instruments to measure absolute gravity. He proposed and led an endeavor that lasted 20 years: the global gravity net and its standardization, that was officially adopted by the International Association of Geodesy at the Moscow 1971 General Assembly. Nowadays, this reference system (IGSN 71: International Gravity Standardization Net) also represents a basic instrument for international cooperation and is universally adopted. Following the deployment of the global gravity net, the precision of the IGSN 71 gravity values increased all over the world from  $10^{-5}$  to  $10^{-8}$ .

In Italy, he actively participated in the compilation of the First Gravity Map of Italy (Italian Geodetic Commission, 1972), by surveying large areas and, by means of remotely controlled gravity-meters, continental platforms, and by cooperating in the gravity data process. For the Second Gravity Map of Italy (CNR, 1985), he surveyed all the Italian seas by means of gravity-meters on board surface vessels. The results of these measurements have brought a fundamental contribution to the knowledge of the geological structure of the Italian seas, of the Mediterranean tectonics and, in particular, of the Italian peninsula.

Such studies, extended later to all the Mediterranean sea, also led to the compilation (for the IOC of UNESCO) first of the IBCM 1:1,000,000, published in 10 sheets in 1981, and later (1985-1999) to the overlay sheets with the gravity and magnetic anomalies, the seismicity and other geological and geophysical parameters. This work was accomplished with international cooperation (he served as president of the Editorial Board).

Carlo Morelli carried out another important research activity which was in Applied Seismics. Between 1956 and 1982 he covered many Deep Seismic Sounding Profiles (DSSP). He started in the Alps with the Lago Lagorai experiment, and progressively extended the profiles to all the Italian peninsula and to the surrounding seas: he acted as the responsible of the Italian group. The entire DSSP programme was performed as a European cooperation, mostly in collaboration with German institutes. Finally, he acted as coordinator of the southern segment (Alps-Tunisia) of the European Geotraverse (from 1981 to 1988 he was member of the Scientific Coordinating Committee), an interdisciplinary study of the crust and upper mantle promoted by the European Science Foundation. He also carried out heat flow surveys in the deep seas around Italy.

His aim was a first step towards the achievement of a 3D structural model of the Earth’s crust in Italy through the interpretation of geophysical data. This structural model, that offered a fundamental knowledge about the deep structures in Italy, is a basic piece of information indispensable for the advancement of the geological and geophysical understanding of the Earth’s interior and also for the exploration and exploitation of energy and mineral resources, for the protection of the environment and for the sustainability of large industrial plants. We have to mention that the success of his initiatives came from the efforts of all participants, performed mostly within national and/or international cooperation projects. The quality of the international collaboration was essential and often led to a change in our fundamental knowledge.

The above mentioned successful research projects fostered the CNR's Strategic Program "Crosta Profonda" (CROP), that Morelli promoted with the contribution of a joint venture of public institutions and industries (ENI, ENEL, ENEA, CNR). CROP was an interdisciplinary project based on deep reflection seismic acquisitions on land and offshore. The profiles that were acquired represent a contribution to the knowledge of the deep crustal structures and are equally important for science, for the economical exploitation of geo-resources, and for the prevention of geological damage.

An important consequence of all these projects is the professional education of several hundreds of highly specialized researchers, many of them working within the framework of the National Institute of Oceanography and Experimental Geophysics (OGS), and adhering freely to the coordinating GNGTS, a national forum where ideas and results achieved in solid Earth geophysics can be presented and discussed.

Carlo Morelli gave an outstanding example of scientific commitment and broad interest to a whole generation of geophysical researchers in Europe. During his life he achieved all his scientific targets. He was a man of direct and rapid action, he expected always the most from everybody and he inspired enthusiasm in anybody capable of supporting his zeal.

Carlo Morelli is the author of 327 scientific papers (215 of which as the only author), mostly in international journals. He also authored one volume: *Gravimetria* (Del Bianco ed., Udine, 1968, 576 pp). The complete list of his publications is available on: [www.istitutoveneto.it](http://www.istitutoveneto.it).

Carlo Morelli passed away on December 30, 2007 after a long post-operational treatment. His wife survives him.

## Reminiscences about prof. Carlo Morelli

I met prof. Morelli in the Sixties and have followed his national and international scientific activities with interest and admiration. During the period from 1980 to 2000, I had opportunity of collaborating with him on two particular occasions and thereby came to better appreciate both his human and scientific qualities.

The first involved the management of the “*Gruppo Nazionale di Geofisica della Terra Solida*” of which he was the Scientific committee President and I the Director. The second was



the “*Progetto Crosta Profonda*” (CROP). Prof. Morelli was the promoter of the project and became the President of the Scientific Committee while I was a member of the Coordinating Committee.

In both these experiences, I could observe and appreciate his extraordinary talents especially in promoting and carrying out new projects, and in following new international research. He was a tireless worker and his great passion for scientific research served as an incentive to all who

worked with him. Prof. Morelli continuously showed interest and enthusiasm for new ideas and projects and as soon as he recognized the scientific validity of a project, he was always anxious to force its accomplishment; when difficulties arose, he determined to overcome them.

The geophysical community can easily recognize that through his enthusiasm and dedication we have been able to initiate, carry through and complete very important national and international projects. His work and memory have found a permanent home in the international Applied Geophysics community.

*Marcello Bernabini*

former full professor of Applied Geophysics,  
University “La Sapienza” Rome, Italy  
and director (1980-1994) of the GNGTS

I was an undergraduate student in Mathematics and Physics at the University of Bari and I attended my first university lesson given by prof. Carlo Morelli. At that time, he had been in Bari for a few years having come from the University of Padova (1953), as Professor of Geodesy, he was the Director of the Physics Institute and in-charge professor of Physics I and Physics II, the so-called “megaphysics” exam, for the biannual undergraduate courses in “Physics”, “Mathematics” and “Mathematics and Physics” of the Faculty of Science.

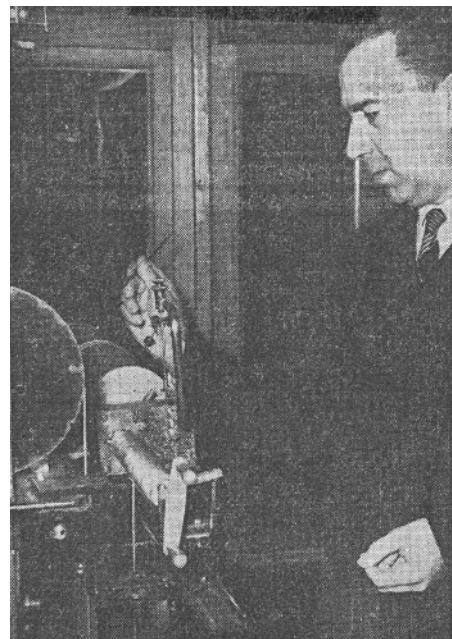
As far as I was concerned, I had passed my “maturita’ classica” with flying colours, and was extremely enthusiastic about physics and very happy to attend my first university lesson in that subject.



Before starting the lesson, prof. Morelli, asked us about what kind of school leaving exam we had taken, (in those days only students from a classical or scientific lyceum could go to university), and without giving any kind of advise about the fact that mathematical analysis could be a preparatory step in learning physics, he started his lesson with the theory of errors.

He praised the students coming from a “classical lyceum” referring to their considerable cultural background: I remember, for example, the usefulness of knowing the Greek alphabet in using certain symbols or the philosophical concept of the difficulty of getting to the knowledge of the truth, which adapted well to the impossibility of obtaining a true measure of greatness; but, then, he threw them completely off balance when, without turning a hair, he passed from sums to integrals, which, to students coming from a classical lyceum simply looked like a serpent. So, we realized, without getting any advice, that we would not have followed anyway, that we would have to learn mathematical analysis before approaching physics.

I remember him at a later stage during the physics exams: as a student I defined him as the “great film director”. Also in the second biennium, as Professor of Physics of the Earth, Geodesy and Technical Physics (subjects which now belong to Applied Geophysics), I remember him jumping from technical-scientific subjects to human and psychological ones. I remember the way he used to do exams by assigning a block of questions to students, by chance, that covered the whole programme: the method helped the student prepare him/herself and reassured him/her about the actual contents and objectivity of the exam itself.



Between the second half of the 1950s and the first years of the 1960s, prof. Morelli became Professor of Physics of the Earth, he started and directed the Institute for Geodesy and Geophysics and last but not least, was Dean of the Faculty of Mathematical, Physical and Natural Sciences; he was already, (since 1949), Director of the Experimental and Geophysical Observatory in Trieste.

In those years, many students obtained their degree, at the University of Bari, in “Physics” or in “Mathematics and Physics” with theses in Physics of the Earth and amongst these about 50% were women: something that for those years, was really exceptional. I was one of them and later became a very young and enthusiastic assistant in Geodesy.

I remember prof. Morelli, the Director, austere and demanding in respecting the timetables of the Institute and making them be respected: timetables that had in any case been freely chosen.

I remember him as a tireless worker who managed, finding a moment even on a Sunday morning, to be close to young people in difficulty offering them the comfort of his human experience. I remember him honouring all his academic engagements, as well as his appointments with the students, in spite of his endless and important national and international engagements.

I remember him tenaciously, correctly and transparently and sometimes even with the attitude

of an impertinent little boy, pursue the objectives of his work. His relations with everybody (students, collaborators and authorities) were dealt with as a kind of open game where everybody exploited their abilities to the utmost.

In those years, numerous lines of research were started at the Institute of Geodesy and Geophysics of the University of Bari, such as: gravimetry, magnetism, geothermy, radioactivity of the atmosphere, climatology and meteorology.

I remember when, in 1963, prof. Morelli was transferred to the University of Trieste. A few years later, I also joined that University.

I remember the enthusiasm and the commitment, that led prof. Morelli, in the following years, to overcome all the difficulties connected to the realization, involving a great deal of collaboration with national and international bodies, of some grandiose and extremely useful works such as: the Geophysical Survey of the Mediterranean Sea and the International Gravity Standardization Net.

I remember his determining thrust in the realization of the Gravimetric Map of Italy on a 1:500,000 scale, for which the Digital Model of the Italian Territory was a preparatory work; this work, published in 1986, was created with the collaboration of the University of Lecce, the CNR, AGIP, and the National Geological Service.

I remember his wonderful organizational skills, the speed with which he would pass from the conception of a project to its realization, his commitment to crustal studies and ... many, many other things. The fondest memory I have of prof. Morelli, is that for me, and I think for many other university students of the fifties too, he was a teacher of didactics, science and commitment and correctness in carrying out our job. With great humanity, he forged our intelligence and was a role model for our professional lives: we will always be profoundly indebted to him for this.

*Maria Teresa Carrozzo*  
full professor of Applied Geophysics,  
University of Lecce, Italy

I had the pleasure of meeting prof. Carlo Morelli in Vienna in 1960 on the occasion of one of the EAEG congresses I had participated in as geophysicist of the mineral department of AGIP.

Ever since 1954 I had heard about him and his fame as researcher and creator of geophysical

projects when I had taken the exam in Geodesy and Gravimetry during my university studies. Later, I had the chance to appreciate his remarkable managerial abilities as the person responsible in the OGS for making useful contacts with AGIP.

Our interactions became consolidated and constant when the Sub-Commission for Gravimetry of the Italian Geodetic Commission, thanks to prof. Morelli, set down a precise programme to build a new Gravimetric Map of Italy, for which AGIP



contributed 217,000 stations.

Other fruitful contacts were made between CNR and AGIP when the management of the latter company decided to realize an Aeromagnetic Map of Italy and the surrounding seas, to which, again thanks to prof. Morelli, the CNR contributed by making surveys of some Alpine zones.

Lastly, contacts were intensified, particularly with prof. Morelli, when the Italian Group for Geophysics of the Solid Earth launched the “Progetto Finalizzato per la Geodinamica”. AGIP made a noteworthy financial contribution towards this project in order to realize certain profiles together with the CNR and the ENEL company.

The universal esteem of the management and all the employees of AGIP, both geophysicists and geologists, for the unforgettable prof. Carlo Morelli, has been and will always be extremely vivid, both for his scientific and his managerial capabilities, and, above-all for his deep humanity which always made him loved and respected by all those who had the good fortune to know him.

I have always considered myself lucky to have known him and will continue to do so for the rest of my days.

I strongly hope that a plaque in his memory can be placed somewhere suitable at the CNR or in a university environment.

*Emanuele Cassano*

former director for Studies and Geophysical  
Methodologies, AGIP, Milan, Italy

While recollecting my long acquaintance with prof. Carlo Morelli, I can distinguish two periods. During the first there was competition: in the post world war 2 years (1950's and 1960's) two organizations (unfortunately competing) were active in Italy in the field of geophysical exploration: the OGS (Trieste), created and headed by prof. Morelli, and the Fondazione Lerici (Politecnico di Milano), each one trying to win domestic and foreign contracts. I worked for the latter one and for this reason I considered Carlo Morelli as a competitor to beat. However, I must recall his loyal help on some occasions even in that period, like during our investigation of the Messina Strait (1955) when the OGS ship and the marine seismic cable enabled us to carry out the offshore survey for the designed bridge (nowadays still in the planning phase!).



When I left the field of industrial exploration for a University chair, my relationship with Carlo Morelli became that of a younger (not very younger) colleague and friend to a senior one. I tried to follow him (this was a rather difficult task, considering his indefatigable activity) in order to support his many initiatives. First of all I'll mention the development of the deep seismic soundings. Carlo was one of the European leaders who, in the frame of the European Seismolog-

ical Commission, planned and realized the network of deep seismic profiles revealing the crustal structure and the geometry of the Moho boundary from the Scandinavian region to the Iberian peninsula in the SW, to the Russian plate in the NE and, across the Alpine chain, to the Mediterranean Sea and North Africa.

One of the most remarkable achievements of prof. Morelli, acknowledged by the international scientific community, was the proposal and guidance that led to the establishment of the global gravity net. I must mention, because it is unique in the history of geophysics in our country (where the organization of a cooperative investigation is always a very difficult task) the realization of a network of deep seismic profiles criss-crossing the Italian peninsula and the surrounding seas. The results of this survey are outstanding, the central Mediterranean region and the Alpine range being today one of the areas of the world where the crustal structure is better known in detail; moreover, the data collected have very important practical issues, like the study of seismogenesis and of volcanic activity.

Such achievements would have been impossible without the energy and skill of Carlo Morelli.

*Roberto Cassinis*  
former full professor of Earth Geophysics,  
University of Milan, Italy

Carlo Morelli was a great Teacher. He was the founder of crustal geophysics in Italy after the Second World War. His winning personality and his indomitable energy led him to deal with specialists in Earth Sciences in the most qualified environments of the West from the second half of the 20th century to our days. Last November, after a long and tormented post-operational convalescence, a few weeks from his demise, he was in Rome, present and with it, in his typical style, at the end-of-year National Geophysics Congress.

Contrary to traditional Italian scientists, who are rather closed and reserved, Carlo Morelli followed with a passion the organization of the Italian research efforts in his field and in the framework of the most lively international relations. These relations were the strong points on which the financing and the acquisition of the gravimetric data interpretations realized on a wide scale (the Mediterranean Sea and surrounding mountain chains) were based. I don't think Carlo Morelli was really interested in classical Geology, a field he probably considered a bit boring. Nevertheless, he always showed a considerable appreciation for the innovative interpretations coming from regional Tectonics and Structural Geology, sometimes exhaulting them.

Carlo Morelli mingled with the best geologists of his times. At the end of the 1950's and 1960's he met Raimondo Selli several times. I remember our meetings in Bologna between trains to Rome. Some veterans like me will remember our worry about the timetables and the connections!

But those were other times, full of movement and enthusiasm! And in these reminiscences, full of emotions, we relive that wonderful, exalting epoch.

*Alberto Castellarin*  
full professor of Geology,  
University of Bologna, Italy

I had the great opportunity of knowing Carlo Morelli and other geophysicists (Ansorge, Berckhemer, Cassinis, Giese, Kissling, Mueller, Nicolich, Panza, Prodehl, Vecchia) during my long geological journey across the Alps. I benefited a lot from those contacts. For the first time, during the Ivrea-Verbanò Symposia (1968 and 1978), the hidden heart of the collisional belt was amazingly illuminated. The deep structure of the Alps, previously envisaged by Argand's creativity, was finally tested and verified. A number of consequent advances given by national and international programmes, from the Geodynamics project through the Structural model of Italy, to the European Geotraverse and the last gigantic enterprise of exploring the Italian surface and marine crust (CROP, CROP-ECORS, TRANSALP), all of which fundamentally contributed to the investigation of the Alpine lithosphere. In my view, the most innovative results were reached thanks to the constructive integration of surface geology with deep geophysical soundings and the petrological evaluation of rocks metamorphosed at depth. This approach was one of Morelli's principal goals. Since

the beginning of his career he attempted to assemble people from distant scientific worlds, to really integrate geologists and geophysicists with the aim of reaching a fruitful and permanent collaboration. This effort was successfully pursued in all the enterprises he promoted, co-ordinated or directed by Carlo Morelli with great tenacity, authority and engineering pragmatism. The great success of all these projects are the real proof of the very important role played by Carlo



Morelli in Italian and European geosciences in the last decades. For his studies and his ability of promoting joint research projects, the University of Padua conferred the honoris causa degree in Geological Sciences (December 3, 2004) to Carlo Morelli. The ceremony was followed by a short seminar on the structural setting and geodynamic evolution of the Alps and Apennines, summarizing the major results of the CROP project. The ceremony was held in the "Archivio antico" and was organized by Barchi, Castellarin, Doglioni, Nicolich, Scandone and myself, which emphasized the fruitful integration of geology and geophysics favoured by Carlo Morelli. Acting as chairman with his "grande verve", Morelli stimulated and directed the final discussion, demonstrating again his great love for advances and problems of pure and applied geosciences. A lunch attended by numerous admirers and friends properly concluded Morelli's celebration. Finally, I would like to remember with great nostalgia the encouragement and generous friendship he has always reserved towards me.

*Giorgio V. Dal Piaz*  
full professor of Geology,  
University of Padova, Italy

I had the opportunity of knowing Carlo Morelli only during the last quarter of his life and career. In spite of being close to retirement and as Emeritus Professor, Carlo Morelli continued to be a permanent presence and reference in our Earth Sciences community at meetings and in a number of volunteer organizations and projects. He was a fine gentleman, an untiring scientist and a generous and enthusiastic colleague, inspiring an endless number of initiatives. In 2002, while talking to Peter Giese, I was showing appreciation for the intense activity that Peter had in the Andes. He replied: "This is nothing with respect to Carlo Morelli's energy". Carlo was always transmitting a passion for research, able to stimulate and encourage lots of geophysicists and geologists to work more in depth, to collect new data, to elaborate them. Reading his bibliography, the amount of pioneering work that Carlo Morelli achieved between the 1950s and 1970s in Mediterranean geophysics is evident. During the 1980s and 1990s, Carlo Morelli was the founder of the Italian project Crop, one of his numerous successes, the study of the deep crust in Italy. He was one of those scientists who did not work for a living, but lived for work. But another rare capacity was to make many people work hard, which gave very important results for the advancement of knowledge.

We will miss his tall figure, always ready to switch his serious attitude to a warm smile for a friend.

*Carlo Doglioni*

full professor of Geology,  
University "La Sapienza", Rome, Italy

I initiated to know prof. Carlo Morelli in the late 1950s in Rome, in the offices of the International Petroleum, a leading consultant and managing services group for hydrocarbon exploration. Soon later, prof. Morelli transferred from the university of Bari and joined the University of Trieste, called to cover the chair of Applied Geophysics at the engineering faculty. At the same time, as president of OGS (Osservatorio Geofisico Sperimentale), then small state Institution of recent foundation, he initiated to conduct its first geophysical services (gravity, magnetic, seismics, geoelectric) for the petroleum industry and oceanographic studies with the cooperation of prof. F. Mosetti.



From the International Petroleum (a group headed by a prestigious geoscientists: dr M.P. Marchetti) prof. Morelli obtained various geophysical service contracts, especially seismic contracts in Italy. For such reason prof. Morelli frequented the offices of the International Petroleum and, as chief geophysicist of this group, I had the opportunity to meet prof. Morelli many times to dis-

cuss the results of the geophysical services performed by OGS.

I remember with great pleasure its bright conversation and I was fascinated by the enthusiasm he manifested all times, accompanied by a kind way of keeping the interlocutor continually concentrated on the specific matter of the technical meeting for hours without to lose one only minute for generic breaks.

In the period late fifties - initial sixties the hydrocarbon exploration activity increased considerably and also in Italy the seismic reflection services expanded vigorously.

During meetings I had in Rome with prof. Morelli in 1962 and 1963 he proposed me more times to enter in the academic career at the University, simultaneously to a factive cooperation with the seismic exploration activity of the OGS. At the beginning of 1964 I accepted his offer and on April 1 I initiated a tight, exciting collaboration with him as assistant professor of Applied Geophysics with lectures in seismic exploration. On September 1, 1964 prof. Morelli charged me also with the direction of the seismic division of OGS. Followed fantastic years of very fruitful collaboration: OGS expanded continually its activity adopting the revolutionary digital techniques of the multifold seismic exploration which ensured a long prosperous trending, the national leadership in the field of the Applied Geophysics and prestige in Europe.

It is a great merit of prof. Morelli the transformation of a small observatory (OGS) into a big advanced Geoscience Institution that performed prestigious large-scale pioneering exploration projects and high-tech geophysical services for the industry. A particular mention is due to the exploration of the entire Mediterranean Sea from Gibraltar to the Levantine Sea. This project disclosed the stratigraphy, tectonics and geodynamics of this large complex basin, previously almost, completely unknown. In the field of the engineering geophysics and oceanography it is to mention a long sequence of projects like for example the studies conducted for the gas-pipeline Algeria-Italy.

I'm proud to have closely collaborated with such an extraordinary geophysical personality along with all the virtuous period of expansion of OGS, copublishing with him important pioneering papers of international interest.

I remember prof. Morelli with great esteem for its total dedication to the geophysics, its incomparable propulsive force in attainment of fixed difficult targets, its untiring pressure of motivation of collaborators. The Italian exploration geophysics must recognize to prof. Carlo Morelli a distinctive leading position and large part of its most important results.

I consider a lucky event of my life my encounter with prof. Morelli and I wish every young geophysicist to have similar chance.

Dear Carlo Morelli a big hug and a memory forever.



*Icilio Renato Finetti*  
full professor of Applied Geophysics,  
University of Trieste, Italy

I had very close contacts with Morelli from the beginning of my career. I still admire his marvellous organization of the various campaigns of explosion seismic investigations of the Alps with Lago Lagorai as one of the central shotpoints. He gave an outstanding example of scientific engagement and broad interest to a whole generation of geophysical researchers in Europe, including prof. Peter Giese who past away before him.

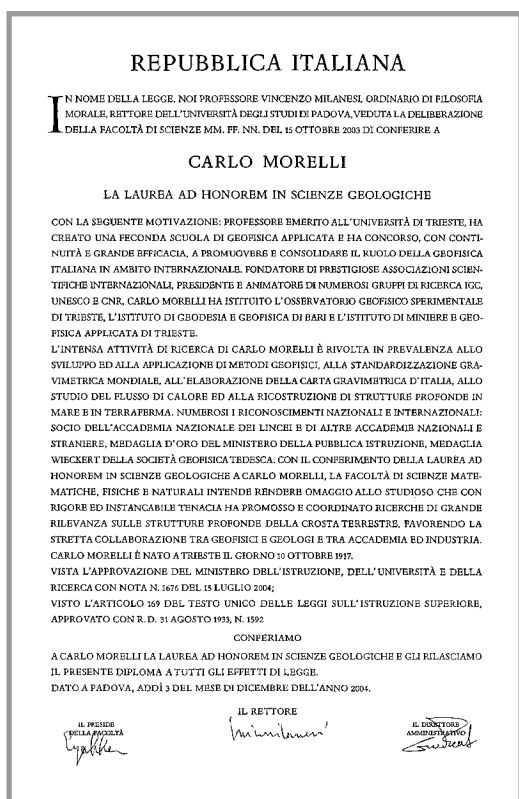
I am sure he will enjoy the light of heaven.

*Karl Fuchs*

former full professor of Geophysics,  
University of Karlsruhe, Germany

When I think of prof. Morelli I think about gravimetry. Not only because, when I was a young physicist with a fresh degree in solid state physics, he introduced me to the research topic to which I would have dedicated most part of my carrier, but also because he was for many many years the soul of gravimetry. Prof Morelli was deeply attached to gravimetry. He introduced this discipline into the research institute named Osservatorio Geofisico Sperimentale (OGS), when he was its President; he strongly supported the establishment of the Italian Gravity Reference Network in 1955; OGS still manages and uses the marine gravity data set which was acquired in the Mediterranean Sea under Morelli's coordination. There is, however, no doubt that his most important achievement in this field was the International Gravity Standardization Network 1971.

The net, which has served as an international reference network, contains 1854 stations distributed worldwide. The acceleration of gravity at each point was determined by a least-squares adjustment that included a number of absolute gravity measurements and a multitude of relative gravity measurements that interconnected all stations. An enormous international effort that was carried out under the coordination of prof. Morelli. He was for several years President of the International Gravity Commission, a body of the International Association of Geodesy. The Commission plays an important role as reference authority in this field. I remember the meetings of the Gravity Commission, first in Paris, and then in Toulouse both as an eagerly awaited event because of the friendly environment and high level of the discussions. During the last years of his presidency, prof Morelli sensed the role that absolute gravimetry could play and in particular by Italy thanks to the effort of the Italian Institute of Metrology "G. Colonnetti" where in the late 1970s researchers





were developing a transportable absolute gravity meter. It is certainly due to prof. Morelli's supporting effort if absolute gravimetry has "spoken in Italian" for several years and if I was introduced to an exciting research activity that has dominated my scientific life.

*Iginio Marson*

full professor of Applied Geophysics,  
University of Trieste, Italy  
and President of OGS

I was one of his first students to graduate in Bari in 1957. The title of the thesis: Geothermy. In those days! What does this man want from me?

But he was a person who always looked ahead, always had up-to-date information, never still. And if he respected you, he pushed you and created good opportunities for you.

The first years were tough: "Professor, I've done such and such". "And why didn't you do the other thing too?" Never gave you any satisfaction. No, I tell a lie, the only compliment I got from him was for a work I did in 2003.

He liked Geothermy.

What do I owe him? That he chose me and always pushed me on: "Mongelli: never do later what you can do now".

I learnt this from him and passed it on to others.

*Francesco Mongelli*

former full professor of Earth Physics,  
University of Bari, Italy

I remember the Morelli of 1960s and 1970s and his complete absorption in developing OGS, an *ante-litteram* spin-off offering geophysical services to oil, energy and mineral resource industries and to scientific institutions. At that time he was a very demanding and obstinate scientific leader and industrial manager. Anyway, his tireless presence all around the clock, willing to help and to solve problems, transmitted energy and enthusiasm to the technicians and researchers working in the field, reaching important goals. The industrial applications of geophysics were used mainly for collecting financial support to reach new advancing scientific targets in Earth Sciences.

His devotion to research and to university education is testified by his curriculum and by his keen participation in national and international science institutions. Once the OGS ad-



venture was terminated, an end point where he realized that it was impossible to conciliate competitive services and applications to the demands of industry and university or institutional studies without external pressure.

He accepted acknowledgments from Academies and Universities, and promoted high quality national and international cooperation projects which were essential for our knowledge of the Earth's interior, for example through the deep seismic investigations for the structural model of Italy, the European Geotraverse, the CROP programme the international research studies (geophysics, oceanography and geology), that mapped the Mediterranean Sea.

*Rinaldo Nicolich*

full professor of Applied Geophysics,  
University of Trieste, Italy

Prof. Morelli closely accompanied the beginning of my professional career, when I started my Ph.D. work at Munich in 1962 supervised by prof. Giese under the directorate of prof. Angenheister. The Lago Lagorai explosions, which prof. Morelli organized, were a keystone of Eastern Alpine research. Personally, they became the basis of my own Ph.D. thesis that prof. Morelli had



fully published in the *Bollettino di Geofisica Teorica ed Applicata*, which started a life-long scientific friendship. The close connection and cooperation of prof. Giese and prof. Morelli were an outstanding example of how fruitful international cooperation and trust in each other leads to extremely successful research with benefits for all sides. One of the last large-scale experiments we were all involved in was the European Geotraverse from which the southern and central part gained much from his personal engagement in organizing shotpoints and pushing Italian cooperation to a very large scale. Since I am retired, I started, together with Walter Mooney, work on a book on explosion seismology with emphasis on its historical development. Within the Central European history, Carlo Morelli is one of a small number of outstanding scientists, who pushed crustal research projects most successfully. He gave an outstanding example of scientific engagement

and attained broad interest in a whole generation of geophysical researchers in Europe, including prof. Peter Giese, who unfortunately has already past away. I am sure, prof. Morelli will be remembered by future generations of Earth scientists as an outstanding leading personality of European geophysical research in the second half of the 20th century.

*Claus Prodehl*

former full professor of Geophysics,  
University of Karlsruhe, Germany

For me it's very strange, very unnatural, to think of not meeting Carlo Morelli any longer, not being able to hear his voice, to see his soft smile. The formidable *Old Lion* (I remember his rather puzzled look the first time I used this nickname) passed away so young in spirit and still very much full of scientific curiosity, just like a youngster, a novice researcher.

From the end of the sixties to the beginning of the seventies Morelli was a myth for a great many young researchers, myself included, who were only just beginning to open their eyes and understand that geology was not only to do with "*mente et malleo*" and possibly with a good pair of walking boots. Earth Sciences was going through that great revolution which generated the main principles of global tectonics and the scientific ferment was im-

mense. Morelli was a protagonist of this adventure, with the great geophysical campaigns of the OGS on the entire Mediterranean Basin and with the first seismic experiments of crust exploration in the Alps and Apennines. When I had my first chance of chatting with Morelli (maybe at a CIESM meeting) I was struck by how in reality this "mythical figure" was such a kind and amiable character with a very healthy sense of self irony. I have heard that in his years as president of the Experimental Geophysics Observatory of Trieste Morelli was a strict and demanding boss. But one thing that we were all immensely proud of was that an Italian institution was so efficient and very much on a par with any equivalent institution at an international level.

From the mid-seventies to the beginning of the eighties I was given the opportunity of my first real scientific adventure working for more than five years, in a coordinating role, in the *Progetto Finalizzato Geodinamica* of the CNR. It was then that I had the chance of getting to know Carlo Morelli better and of appreciating not only his obvious scientific qualities, but his very humane traits. Morelli was a born "*presidente*". There wasn't a meeting in which he didn't end up slipping into the role of chairman to all intents and purposes. This came about naturally, with no act of prevarication, because Morelli was able to enliven any discussion with intelligence and class and was always the most balanced but decisive moderator, making sure that everyone had a fair share of the debate. The words that come to mind thinking of the Morelli of those years are absence of protagonism, untiring enthusiasm and authentic scientific curiosity. All this combined with the qualities of a marvellously attentive listener. A lot of time has gone by since then, and thinking of the Morelli of today (of yesterday I should say, unfortunately) the same words come to mind. As far as I'm concerned personally, to these words I'd simply like to add the word affection, an affection which, over the years, has grown and joined an ever greater esteem and admiration.



*Paolo Scandone*  
full professor of Geology,  
University of Pisa, Italy

Few people probably know that Carlo Morelli took an active part in the founding and the work of the European Seismological Commission (ESC) of IASPEI.

The idea of creating a body for European seismologists came to Miss Inge Lehmann (Denmark), Mrs. I. Bobr (Poland) and Mr. C. Charlier (Belgium) in 1947 during the International Association of Seismology meeting at Strasbourg. During the IUGG Oslo meeting in 1948, the European seismologists agreed - still unofficially - on an organization, which they tentatively gave the French name of "Organisation Séismologique Européenne (OSE)". In 1949, four seismologists wrote a letter addressed to all colleagues in Europe and the scientific bodies like IAS and IUGG. It is recognized as the first manifesto for the creation of the future ESC. The European seismologists did respond enthusiastically.

In 1950, Pietro Caloi of the Istituto Nazionale di Geofisica in Rome organized a constituent meeting in Verona, where two options were discussed, namely whether this organization should be a private one or affiliated with the IAS.IUGG. Choosing the latter the society would benefit from the financial support of IUGG.IAS(PEI), but no individual members could be admitted, only member countries. Carlo Morelli, was among the ten Italian seismologists who took part in this meeting in which the Federation of European Seismologists was established. Finally, in 1951 in Brussels, during the IAS General Assembly, the ESC was created and the ESC-IASPEI status, kept until today, was approved.

The first General Assembly of the ESC convened in 1952 in Stuttgart, the second one, organized by Caloi, in Rome. Morelli was, together with Marussi and Bocchio, in the LOC that in 1974



organized the 14th General Assembly of the ESC in Trieste on University of Trieste campus. In his opening speech, on September 16, 1974, the ESC President Stephan Mueller acknowledged the work of Morelli. "There are many reasons for the seismologists of Europe to meet in Italy, and especially in Trieste. The Osservatorio Geofisico

Sperimentale under prof. Carlo Morelli has become world-famous for its dedicated engagement in the geophysical exploration of the Alpine-Mediterranean area."

Later on in 1986, Carlo Morelli became ESC President and served two periods until 1990. The Secretary General at that time was Dieter Mayer-Rosa. At that time, deep seismic sounding was among the most popular scientific issues in ESC and Morelli was an excellent organizer in bringing together scientists from different countries.

I myself recall his decision-making attitude that always led him to take the role of leader, even if somebody else was supposed to have that role. He was a hard-working person and expected

everybody else to act in the same way. My last encounter with him was during the 28<sup>th</sup> General Assembly of the ESC in 2002 in Genoa, where we celebrated the 50<sup>th</sup> Anniversary of ESC. He was among the invited past presidents and general secretaries and was very proud to be part of the ESC history.

*Peter Suhadolc*

professor of Earth Physics, University of Trieste, Italy,  
IASPEI Secretary General,  
and ESC Secretary General (1992-2002)

Carlo Morelli was a prominent and bright scientist and very good person. My memory of him goes to 1995, when I worked at the University of Trieste with prof. Nicolich in the same department where Carlo worked. His ability to work and to produce scientific knowledge deeply astonished me. God rest his soul!

*Alik T. Ismail-Zadeh*

professor of Computational Geodynamics,  
Academy of Sciences, Moscow, Russia  
and IUGG Secretary General

