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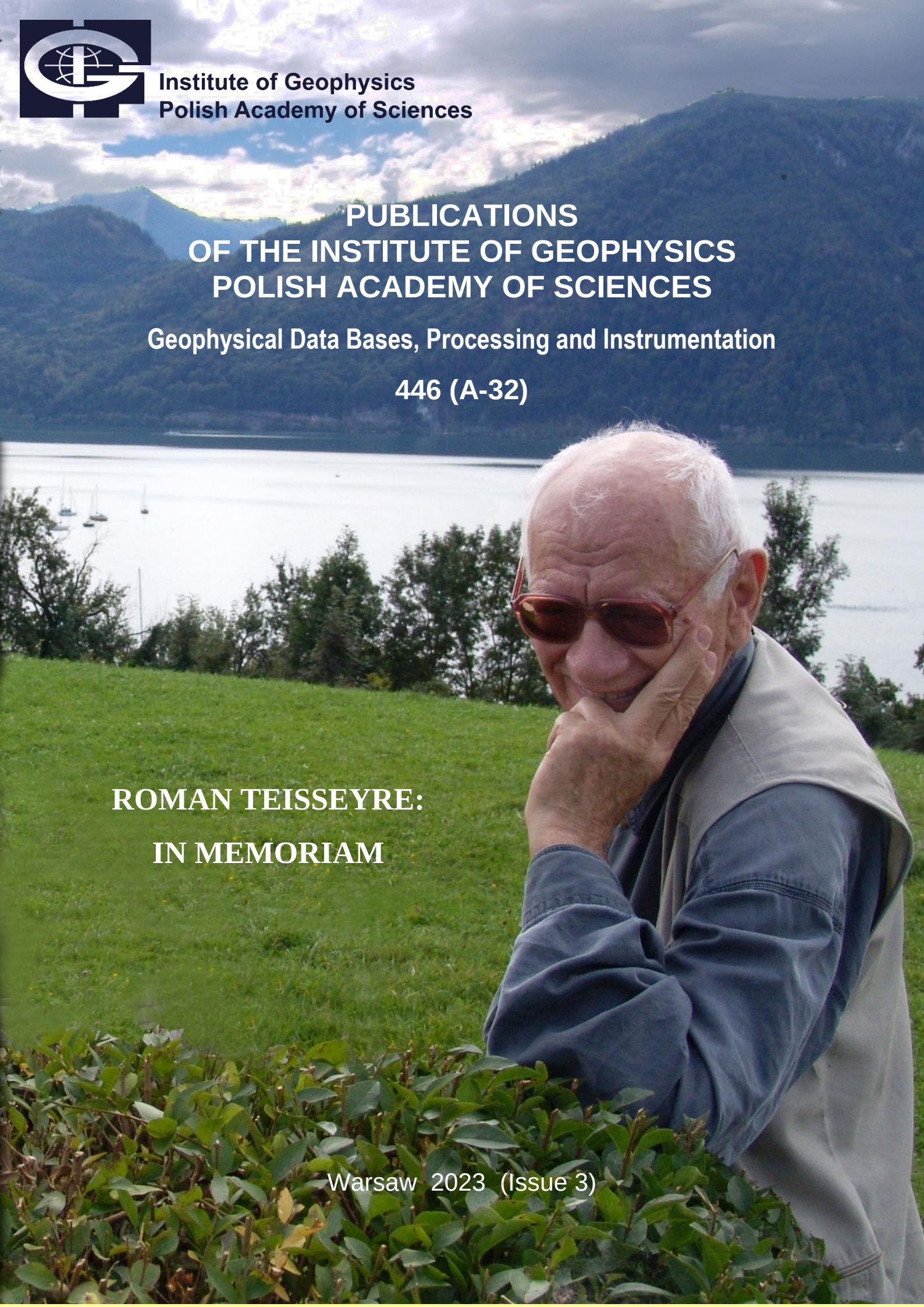
446 (A-32)



ROMAN TEISSEYRE:

IN MEMORIAM

Warsaw 2023 (Issue 3)

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C O N T E N T S

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Preface

Professor Roman Teisseyre, the outstanding modern geophysicist, was one of the most important and influential persons in the whole history of the Institute of Geophysics, Polish Academy of Sciences. His death ended the era of the founders and managers of the Institute who shaped, from its very beginning, the basic scientific profile of our place. Also, the friendly and pleasant atmosphere among the people working there, as initiated by him and the whole group of Institute's founders, was prevalent over the years. He had many, many friends who quickly responded to our appeal to contribute to the present book In Memoriam. In addition to the authors of the contributions presented here, we acknowledge the help and engagement of the following persons: Maria Wernik, Marzena Czarnecka, and Barbara Marianiuk, as well as warm words and encouragement from Renata Dmowska, Wiesława Jankowska, Barbara Romanowicz, and many colleagues and friends in Poland and abroad.

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Professor Roman Teisseyre (1929–2022) Brief Biography of the Prominent Scientist and Outstanding Man

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Roman Teisseyre was born on April 11, 1929, in Lwów (Lviv), to a family with French roots. In 1935, the family moved to Warsaw. After the outbreak of World War II on September 1, 1939, when the country fell under German occupation, Roman continues his school education in the underground classes. By the outbreak of the Warsaw Uprising (August 1, 1944), he managed to complete three grades of junior high school. At the age of 15, being a member of the underground scouting movement, the Polish Gray Scouts (Szare Szeregi), he participates in the uprising fights in the Żoliborz neighborhood, platoon 257 of the Group "Viper" ("Żmija", District II "Żywiciel" of the Home Army's Warsaw Region) taking the pseudonym "Grom". Roman's father Kazimierz and older brother Mieczysław, while fighting in the Uprising in the regions of Czerniaków and the Old Town, were wounded.

After 63 days of the Uprising fights, Kazimierz and Mieczysław are sent to a prisoner-of-war camp in Germany, while Roman and the civilian population go to the transit camp in Pruszków (Dulag 121). Eventually, the Teisseyres go to Jędrzejów and then to Cracow, already free from German occupation, where Roman, after completing the fourth grade of junior high school, obtains a minor high school diploma. The family then moves to Wrocław, upon shorter stays in the towns of Zielona Góra and Jelenia Góra. It should be noted that in these harsh times, young Roman tried to help the family by working in a mill near Cracow and as an industrial guard in Zielona Góra. He completes the first year of senior high school in Jelenia Góra and the second in Wrocław, getting the high school diploma in 1947. He begins studies at the Faculty of Mathematics, Physics, and Chemistry at the University of Wrocław.

In the summer of 1948, he works as an observer in the Magnetic Group of Prof. Henryk Orkisz's team, doing magnetic measurements in the Kłodzko region on behalf of the State Geological Institute. After moving to Warsaw in 1949, he continues his physics studies at the University of Warsaw, also working at the Geophysics Department of the State Geological

Institute, first in the magnetic group and then in the electrical resistivity group of Prof. Henryk Orkisz.

In April 1950, he becomes a research assistant under Prof. Edward Stenz at the Faculty of Geophysics, University of Warsaw, but in September 1951 he moves to the Department of Theoretical Physics as a research assistant to Prof. Leopold Infeld, a famous theoretician working on general relativity, electrodynamics, and field theory, a coworker of Albert Einstein. It would seem that being a member of such a distinguished team, Roman Teisseyre should choose a career as a theoretical physicist.

However, it was the geological/geophysical genes that prevailed in Roman's mind. His grandfather, Wawrzyniec Teisseyre, was a very well-known Polish geologist, a discoverer of the great tectonic zone, named the Teisseyre–Tornquist zone. Also his uncle Henry was a geologist, a well-known specialist in the tectonics of the Carpathians and Sudetes. So, after receiving his master's degree in 1952 on the basis of a thesis on the problem of coordinate systems and equations of motion in the general theory of relativity, Roman decides to move, in August 1953, to the newly established Department of Geophysics of the Polish Academy of Sciences (upgraded to the Institute of Geophysics PAS in 1971) taking the position of head of the seismology department. His scientific career goes on very fast.

In 1955, he becomes the Scientific Secretary of the Polish Committee of the International Geophysical Year. However, he resigns from this position to take the lead of a geophysical expedition to Vietnam. He goes there three times: in 1956, 1957, and 1958. The expeditions established two modern observatories, in Cha-Pa and Phu-Lien, operative in various fields of geophysics until today.

In 1959, at the Faculty of Mathematics and Physics of the University of Warsaw, Roman Teisseyre defends his doctoral thesis titled "The general problem of diffraction on a conducting wedge", whose supervisor was Prof. Leopold Infeld, and then awards research fellowships to Great Britain and France (1959, 1960). Since 1960, he has served as Poland's representative to the European Seismological Commission. Having received the habilitation degree in 1961, he is appointed the Deputy Director for Scientific Matters of the Department of Geophysics PAS. In 1965, he goes to Japan for a year at the International Institute of Seismology in Tokyo as a UNESCO expert. He soon obtains the academic titles of professor of physical sciences: associate in 1967, and full in 1974. As an outstanding scientist, he becomes a Corresponding Member of the Polish Academy of Sciences in 1969, and a full member in 1980.

Roman Teisseyre's wide and very long-lasting (more than 65 years) activity to the benefit of geophysics can be divided into several groups: functions performed at the Institute of Geophysics, PAS; functions in the structures of the Polish Academy of Sciences; functions in foreign scientific bodies, other organizational activities; scientific cooperation; research projects; editions of monographs; the permanent services as a teacher, head and scientific supervisor.

Functions at the Institute of Geophysics, PAS:

- organized the Department of Seismology, the Department of Seismology and Physics of the Earth's Interior, and then the Department of Dynamics of the Earth's Interior – was the head of departments for 50 years (1954–2004);
- served as a Deputy Director of the Institute of Geophysics, PAS, in 1960–1970 and 1973–1992;
- was the Director of the Institute of Geophysics, PAS, from 1970 to 1972 (in total, he held directorial positions for 32 years);
- served as the Editor-in-Chief of the journal *Acta Geophysica Polonica* for 12 years (1994–2005);

- initiated and was a long-time editor of the journal *Publications of the Institute of Geophysics, Polish Academy of Sciences*.

Functions in structures of the Polish Academy of Sciences:

- was a member of the Presidium of the Polish Academy of Sciences in 1973–1981;
- was a Deputy Secretary of Division III of Mathematical, Physical, Chemical, and Geological-Geographical Sciences of the Polish Academy of Sciences from 1973 to 1976;
- served as a Secretary of Division VII of Earth and Mining Sciences of the Polish Academy of Sciences in 1980–1983;
- was Chairman of the Committee on Geophysics of the Polish Academy of Sciences in two terms (1976–1980, 1988–1992);

Functions in foreign scientific bodies:

- became a member of the Finnish Academy of Science and Literature in 1975;
- served as a Vice President in 1972–1976 and then, in 1976–1978, as the President of the European Seismological Commission;
- was a member of the Executive Committee of the International Association of Seismology and Physics of the Earth's Interior (1970–1975);
- was a UNESCO expert at the International Institute of Seismology and Earthquake Engineering, Tokyo (1965–1966);
- in addition, was a member of the editorial committees of foreign geophysical journals: *Gerlands Beitrage*, *Bollettino di Geofisica Teorica e Applicata*, and *Pure and Applied Geophysics*.

Other organizational activities; scientific cooperation:

- in the framework of the International Geophysical Year (1957–1960), became head of the geophysical expedition to Vietnam, where two comprehensive Geophysical Observatories, in Phu-Lien and Cha-Pa, were established.
- by invitation of leading scientific centers, was a Visiting Professor: at the International School of Advanced Studies of the Theoretical Physics Center in Trieste, Italy, 1979–1980; at the University of Strasbourg, France, 1984; and at Hokkaido University in Sapporo, Japan, 1999.
- participated in several polar scientific expeditions to Spitsbergen (1962, 1974, 2000).
- carried out close cooperation with many scientific institutions and scientists abroad: in Japan (Earthquake Research Institute in Tokyo, University of Hokkaido in Sapporo, Institute of Seismology and Volcanology, Tohoku University in Sendai) with Keichi Kasahara, Setumi Miyamura, Syun'ichiro Omote, Teruo Yamashita, Hiroyuki Nagahama; in Finland (University of Helsinki, Institute of Seismology) with Eijo Vesanen; in Italy (Istituto Nationale di Geofisica e Vulcanologia, Rome, Universita degli Studi, Trieste) with Antonio Meloni, Marco Marchetti, Paolo Palangio, Valerio de Rubeis; and in Greece (University of Athens, Physics Department) with Panayiotis Varotsos.

Research

Professor Roman Teisseyre was a prominent member of Polish scientific life. His original scientific output is impressive, comprising almost 400 (390) published papers. He was mainly a theoretician dealing with physics of the Earth's interior. Most of his works are related to

seismology, geodynamics, thermodynamics of the process of rock deformation and fractioning, and the electromagnetic field, but his output is very comprehensive and also includes works initiating new directions of research or summarizing the state of current geophysical knowledge on some problems.

Making an attempt to enlist the areas in which Roman Teisseyre made his most important contributions, one should enumerate the following:

- was one of the world pioneers in developing the dislocation theory of earthquakes,
- introduced the micromorphic description of the medium to seismology,
- advanced the studies on the convection and dynamics of the Earth's mantle,
- established the fundamentals of the theory and interpretation of phenomena occurring prior to earthquakes and mining tremors,
- initiated the study of tremors associated with glacier motion,
- applied the non-Riemannian geometry to the description of deformations, geodynamic fields, and potential fields of the Earth,
- developed the fundamentals of thermodynamics of linear defects and earthquake-related processes,
- studied and interpreted telluric precursors of earthquakes,
- derived the generalized equations of motion and constitutive relations for asymmetric fields in continuous media, as applied to seismology,
- formulated the generalized model of a continuous medium with defects and nucleation of rotation-type deformation.

Edition of monographs:

Among Roman Teisseyre's very important scientific achievements is the editing and co-authorship of a number of multi-volume, unique monographs on the physics and evolution of the Earth's interior. These books synthesize the huge scope of scientific problems of the Earth's interior physics and constitute a very important contribution to world geophysics. The books were issued by leading publishers (Academic Press, Elsevier, PWN), and, since 2010, within the new series, GeoPlanet Book Series, according to the agreement with Springer (presently Springer Nature Switzerland):

- The first, two-volume monograph, (*Physics and Evolution of the Earth's Interior*, 1983, PWN) was published in Polish.
- The flagship monograph in 6 volumes, covering the entire theory of the Earth's interior (*Physics and Evolution of the Earth's Interior*, Elsevier-PWN) was published throughout the years 1984–1993.
- The crowning work of the dislocation theory of seismic sources (*Theory of Earthquake Premonitory and Fracture Processes*, PWN) was published in 1995.
- The earthquake thermodynamics was the topic of the monograph issued in 2001 (*Earthquake Thermodynamics and Phase Transformations in the Earth's Interior*, 2001, Academic Press).

Alongside, the theory of asymmetric medium, in its various aspects, has been discussed as many as three monographs (*Earthquake Source Asymmetry, Structural Media and Rotation Effects*, 2006, Springer-Verlag; *Physics of Asymmetric Continuum: Extreme and Fracture Processes*, 2008, Springer-Verlag; *Asymmetric Continuum: Extreme Processes in Solids and Fluids*, 2014, GeoPlanet Book Series, Springer-Verlag).

Problems of synchronization of various geophysical processes are presented in the 2010 monograph: *Synchronization and Triggering: From Fracture to Earthquake Processes*, 2010, GeoPlanet Book Series, Springer-Verlag.

It should be emphasized that Prof. Roman Teisseyre's work combines theoretical elements with research methods and their interpretation. He directly participated in the organization of seismic research both in our country, especially in mining basins, and abroad, in the study of electromagnetic precursors of earthquakes and rotational effects. A number of works have a clear utilitarian and practical aspect.

In recognition of his achievements, Professor Roman Teisseyre received a number of prestigious honors and awards, including: Officer's Cross (1961) and Commander's Cross (1969) of the Order of Polonia Restituta; Warsaw Uprising Cross (1986); as well as the Awards of Division VII of the Polish Academy of Sciences, Secretary of the Polish Academy of Sciences; Chairman of the Council of Ministers (1995). He holds an honorary doctorate from the AGH University of Science and Technology in Cracow (2004).

The list of functions and important positions that Prof. Roman Teisseyre held, as well as a summary of scientific achievements, does not fill out the entire profile of the Professor as a scientist. After all, one of the most important roles of a scientist is that of a teacher, boss, and scientific supervisor.

At this point I will use my personal recollection. Being a young assistant professor, I used to come to Prof. Roman Teisseyre's office from time to time to present him my latest ideas and the results of the work I had done. I always entered with some anxiety, not being quite sure of the soundness of my ideas. The Professor patiently listened to my not-so-long speech, then invariably stated – "very well done, Zbyszek, very well done, keep it up". And I walked out of that office as if on wings, full of good motivation and energy for further scientific work.

This anecdote, although short, still contains a large amount of information of what was Roman Teisseyre's attitude toward the education of young scientists. It was based on such principles as:

- freedom to search for one's own topic, the most interesting for a young adept in geophysics,
- independence in scientific work, which forces self-education,
- good motivation through encouragement and acknowledgment (avoiding discouraging, demobilizing criticism),
- confidence and faith that the young person will strive to act effectively on his own.

In terms of educational activity, of great importance was also the supervision of doctoral theses and consultations over habilitation treatises. He promoted a group of 20 PhDs, and those people are now world-renowned scientists in the field of seismology and the physics of the Earth's interior. Professor Roman Teisseyre gathered around him a large group of collaborators, professors, and young academicians who, under his leadership, have been intensely developing the theory and conducting research related to seismology: the theory and prediction of earthquakes. He was the founder of a nationally and internationally recognized scientific school (the Polish school of theoretical geophysics). He developed the dislocation theory of earthquakes and new original methods of studying mining and glacial tremors and the mechanisms of those tremors. In his diverse scientific works, he used the whole available apparatus of physics and mathematics, and combined the theory with the methods and interpretation of geophysical research, obtaining outstanding, worldwide renowned and applicable results.

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Roman Teisseyre – the Pride of the Academy

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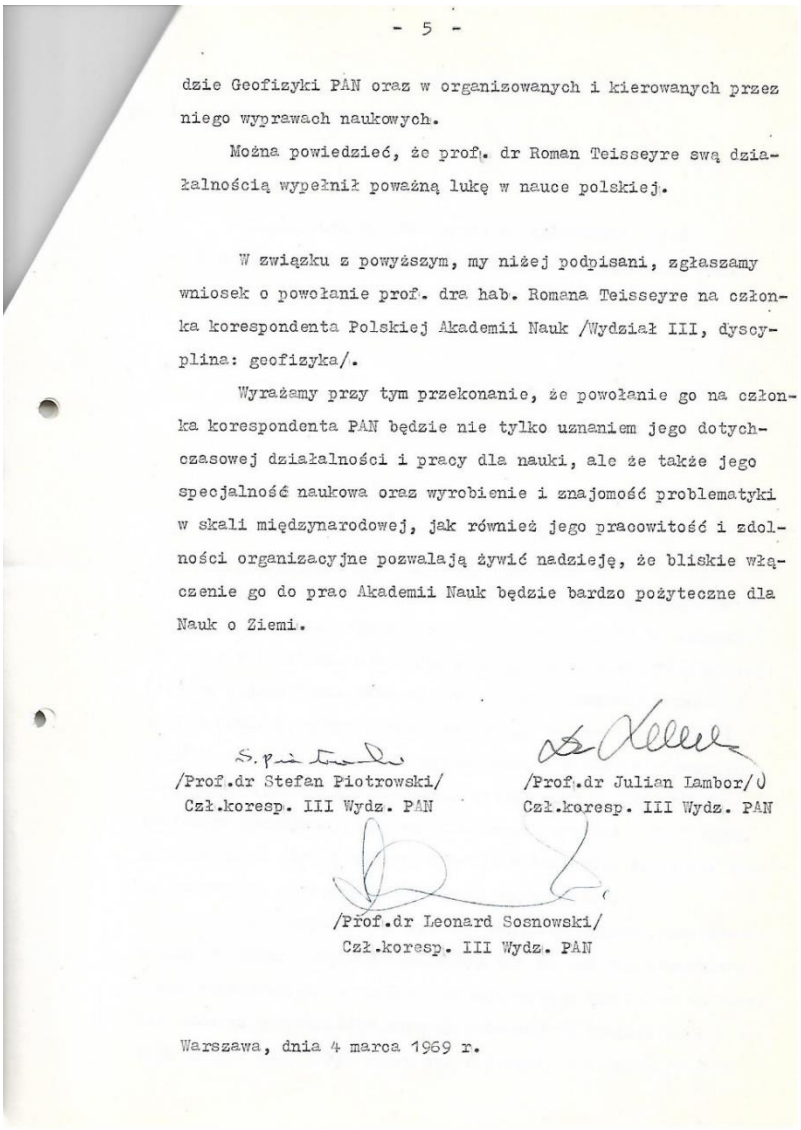
From among colleagues remembering Prof. Roman Teisseyre, I am probably least qualified to write about his achievements. Neither the scientific discipline that he dealt with, is my own; nor I had a chance to directly collaborate with him. When I started my work at the Institute of Geophysics in 1988, Prof. Teisseyre was already a legend and it was too high threshold for me at that time. But soon it turned out that Prof. Teisseyre was very straightforward, open person ready to share his knowledge with younger fellows. It so happened that I had Professor Teisseyre on board when I served as the Director of the Institute of Geophysics. When I had this privilege to play various roles at Polish Academy of Sciences, among them as its Vice President, I could observe how important was Roman for the entire Polish scientific community. I am absolutely sure that others will tell in much better way about Roman's scientific accomplishments (he primarily was a scientist) but let me just mention his invaluable role for organization of Polish science, particularly at the Polish Academy of Sciences. This brief memoir is based on preliminary research of the documents that can be found at the headquarters of the Academy. Let me mention that I had this privilege to get onto first-name terms with Prof. Teisseyre so further in the text I will from time to time call him simply Roman.

The first document that attracted my special attention was Roman's own biography written when he was a candidate to become the corresponding member of the Polish Academy of Sciences, a very elite and that time extremely demanding society. His candidacy was supported by three members of the Academy, the giants in Polish science – Professors Stefan Piotrowski – an astronomer, founder of Warsaw School of Astronomy, Julian Lambor – one of the most famous Polish hydrologists in the 20th century, and Leonard Sosnowski – the founder of semiconductor physics in Poland. They prepared a letter of strong support for Roman in March 1969. From a one-page biography written by Roman one can conclude what was really important for him at that time. He stressed his education (3 classes of gymnasium) at the underground schools which he managed to attend until the outbreak of the Warsaw Uprising. He mentioned his early work in the mill in the neighborhood of Kraków. He graduated from the fourth grade of high school after the liberation of Cracow lands. Then he moved to Zielona Góra to work as an industrial guard. He went through the first grade at Lyceum in Jelenia Góra and the second one in Wrocław. It shows a turbulent period in his life. In that short document, he also explained the choices he made. So in 1955 he was nominated the scientific secretary of the Polish Committee of International Geophysical Year and he resigned from it to be able to

chair the expedition to Vietnam where he went three times, in 1956, 1957, and 1958. Noteworthy are also his fellowships in UK and France (1959 and 1960), participation in a summer expedition to Spitsbergen, and also very prestigious position in Japan as an international expert of UNESCO. Note that we talk about times of communist despotism in Poland when international traveling was not an easy undertaking. He was not a member or not even a supporter of the leading party but even then was allowed to travel overseas. Roman was accepted at the Academy as a corresponding member in 1969. Note that he was then only 40 years old and I want to stress that even nowadays it is not very common that the Academy accepts so young members. It proves how well his research and organizational achievements were taken by academicians that time. It was already most prestigious scientific society in Poland. In their explanations, Professors Piotrowski, Lambor, and Sosnowski stressed not only Roman's scientific achievements but also the support for the scientific discipline that he was active in. In their opinion geophysics at that time was a fledging research domain. In my own judgment, it was also a milestone in the development of seismology and in perceiving geophysics by the Polish scientific community.

Figure 1 presents the last page of the original letter of support to elect Prof. Teisseyre the corresponding member of the Academy.



- 5 -

dzie Geofizyki PAN oraz w organizowanych i kierowanych przez niego wyprawach naukowych.

Można powiedzieć, że prof. dr Roman Teisseyre swą działalnością wypełnił poważną lukę w nauce polskiej.

W związku z powyższym, my niżej podpisani, zgłaszamy wniosek o powołanie prof. dra hab. Romana Teisseyre na członka korespondenta Polskiej Akademii Nauk /Wydział III, dyscyplina: geofizyka/.

Wyrażamy przy tym przekonanie, że powołanie go na członka korespondenta PAN będzie nie tylko uznaniem jego dotychczasowej działalności i pracy dla nauki, ale że także jego specjalność naukowa oraz wyrobienie i znajomość problematyki w skali międzynarodowej, jak również jego pracowitość i zdolności organizacyjne pozwalają żywić nadzieję, że bliskie włączenie go do prac Akademii Nauk będzie bardzo pożyteczne dla Nauk o Ziemi.

/Prof.dr Stefan Piotrowski/
Czł.koresp. III Wydz. PAN

/Prof.dr Julian Lambor/
Czł.koresp. III Wydz. PAN

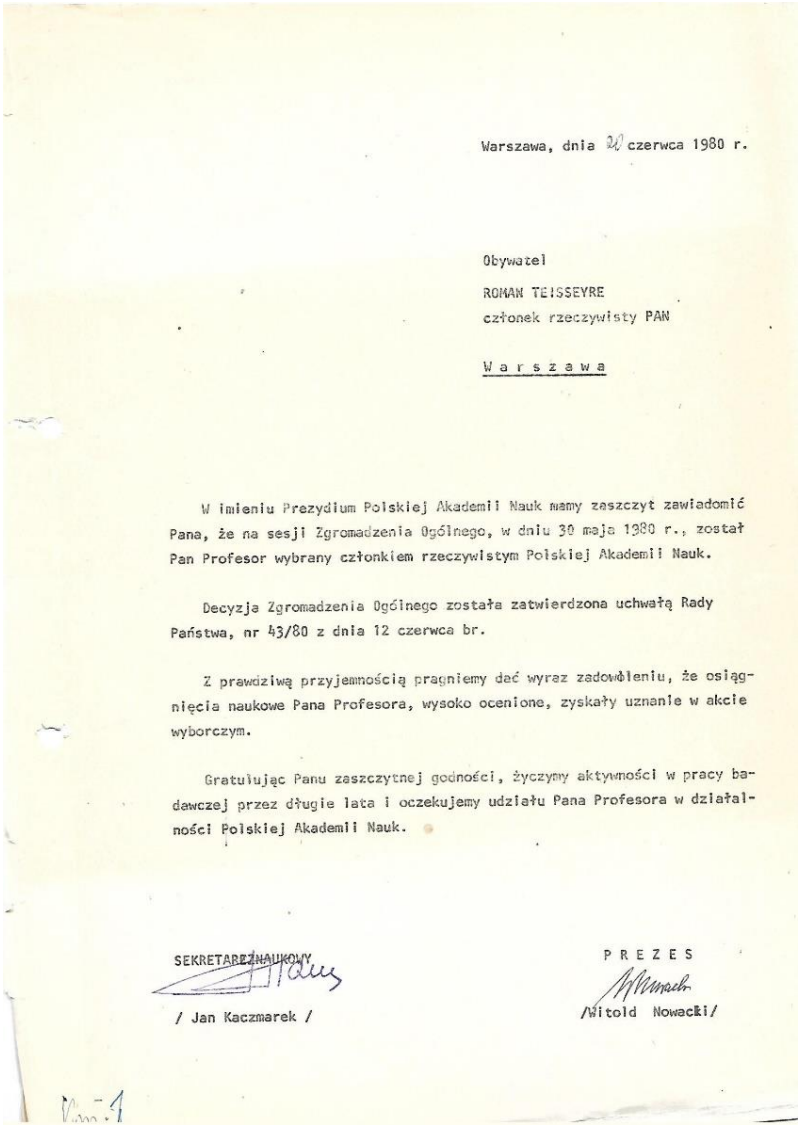
/Prof.dr Leonard Sosnowski/
Czł.koresp. III Wydz. PAN

Warszawa, dnia 4 marca 1969 r.

Fig. 1. Last page of the original letter of support in the process of Prof. Teisseyre's election to the Polish Academy of Sciences with original signatures of Profs. Stefan Piotrowski, Julian Lambor, and Leonard Sosnowski (Excerpts translated by the editors: "… we are convinced that his election (…) will not only be a recognition of his past activities and achievements (…), but his diligence and organizational skills make us believe that his forthcoming participation in the activities of the Academy of Sciences will be of great benefit to Earth Sciences").

The next step in Roman's career in the Academy was an application to nominate him as an ordinary member of the Academy. That time the letter of support written in November 1979 was signed by Professors Jerzy Kostrowicki – a Polish geographer specializing in economic geography and two leading Polish geologists – Roman Ney and Władysław Pożaryski. It was to some extent the coping stone of his academic achievements and the administrative services to our community. Note that in the years 1970 through 1972 he was the director of the Institute of Geophysics and, after that, also at the time when he was accepted as an ordinary member of PAS – he was the deputy director of the Institute responsible for scientific affairs.

He was always active as a member of scientific councils of various institutions and when awarded the ordinary membership of PAS he was seating in the Scientific Council of Geophysical Department of PAS, he was the head of the Scientific Council of Applied Geophysics at AGH University of Science and Technology, and a member of many other organizations. On a different note, I happened to travel with him a lot when we were both members of the scientific council of the Institute of Oceanology PAS starting from 2011. He was already in advanced age but his approach to this task was always conscientious. And as long as he was in a good health condition the time spent with him in Sopot or in the train on the way to Tricity was extremely joyful. His remarks and advise given to that Institute were always to the point.



Warszawa, dnia 20 czerwca 1980 r.

Obywatel
ROMAN TEISSEYRE
członek rzeczywisty PAN

Warszawa

W imieniu Prezydium Polskiej Akademii Nauk mamy zaszczyt zawiadomić Pana, że na sesji Zgromadzenia Ogólnego, w dniu 30 maja 1980 r., został Pan Profesor wybrany członkiem rzeczywistym Polskiej Akademii Nauk.

Decyzja Zgromadzenia Ogólnego została zatwierdzona uchwałą Rady Państwa, nr 43/80 z dnia 12 czerwca br.

Z prawdziwą przyjemnością pragniemy dać wyraz zadowoleniu, że osiągnięcia naukowe Pana Profesora, wysoko ocenione, zyskały uznanie w akcie wyborczym.

Gratulując Panu zaszczytnej godności, życzymy aktywności w pracy badawczej przez długie lata i oczekujemy udziału Pana Profesora w działalności Polskiej Akademii Nauk.

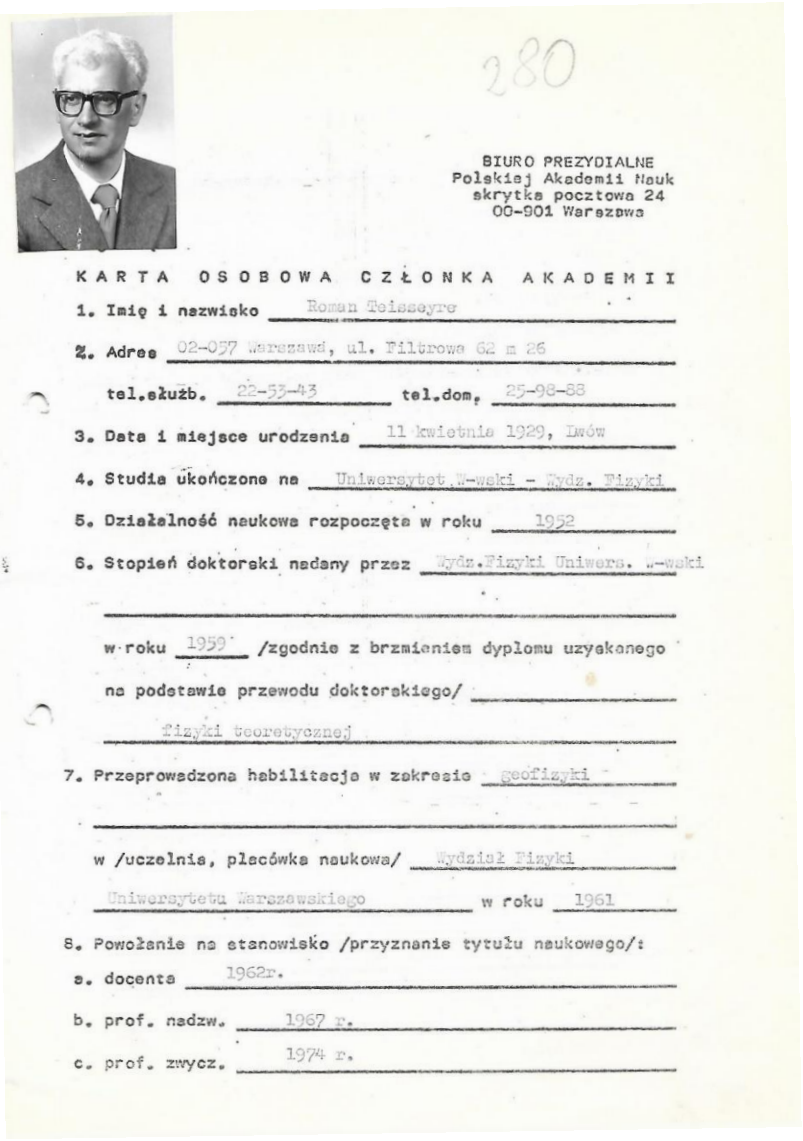
SEKRETARZ NAUKOWY
/ Jan Kaczmarek /

PREZES
/Witold Nowacki/

Fig. 2. Letter of the President of the Polish Academy of Sciences informing about electing Prof. Roman Teisseyre as an ordinary member of the Academy.

Coming back to his application to become an ordinary member of PAS, it was the time when he also served in the Board of the National Committee of Geophysics and Geodesy. And notably, he was the Deputy of the Secretary of Division 3 (Mathematics, Physics, and Chemistry) of the Academy from 1973 to 1976. And starting from 1973 he was also a member of the Presidium of PAS. A special opinion was then prepared by Professors Roman Ney and Zdzisław Kaczmarek. He was elected ordinary member on the 30 May 1980 (see the letter of the President of PAS, Prof. Witold Nowacki, and its Scientific Secretary, Prof. Jan Kaczmarek, Fig. 2).

People very often recall Roman as somebody not interested in any administrative work but it contradicts the facts. He was extremely active member of PAS. I myself remember Roman solving his equations during long meetings, treated by him as the boring ones. At the same time, he was aware of what was being discussed, he simply did not like to unnecessarily lose time. So it is hard to judge what indeed was in his heart. But to provide those contradictory facts showing how frequently wrong is our image of Roman – in 1980 he became the Secretary of the Division 7 of the Academy (Earth and Mining Sciences) and fulfilled that task until 1983. It was an extremely demanding and prestigious job! He had to play the leading role in assessing the institutes working under the umbrella of the Division, was responsible for organizing the elections of the directors of these institutes, and also had to coordinate the work of committees



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BIURO PREZYDIALNE
Polskiej Akademii Nauk
skrytka pocztowa 24
00-901 Warszawa

KARTA OSOBOWA CZŁONKA AKADEMII

1. Imię i nazwisko Roman Teisseyre
2. Adres 02-057 Warszawa, ul. Filtrowa 62 m 26
   tel.służb. 22-53-43 tel.dom. 25-98-88
3. Data i miejsce urodzenia 11 kwietnia 1929, Lwów
4. Studia ukończone na Uniwersytet W-wski - Wydz. Fizyki
5. Działalność naukowa rozpoczęta w roku 1952
6. Stopień doktorski nadany przez Wydz.Fizyki Uniwers. W-wski
   w roku 1959 /zgodnie z brzmieniem dyplomu uzyskanego
   na podstawie przewodu doktorskiego/
   fizyki teoretycznej
7. Przeprowadzona habilitacja w zakresie geofizyki
   w /uczelnia, placówka naukowa/ Wydział Fizyki
   Uniwersytetu Warszawskiego w roku 1961
8. Powołanie na stanowisko /przyznanie tytułu naukowego/:
   a. docenta 1962r.
   b. prof. nadzw. 1967 r.
   c. prof. zwycz. 1974 r.

Fig. 3. Personal data form of the Academy member from 1986 – from archives of the Polish Academy of Sciences.

working for the Division. The divisions also awarded various prizes and the Secretary of the Division played one of the major roles in this task. He is well remembered from that period and he was the boss that everybody really liked. Roman used to avoid conflicts, and was rather a man of consent. Let me also remind one of the activities that I myself appreciate very much. For many years he served as Editor in Chief of *Acta Geophysica Polonica* and it was he that we discussed the process of transferring that journal into its new appearance as *Acta Geophysica*. As the director of the Institute I undertook that task and he was extremely supportive and well understood that we needed a change to make this journal listed in international databases.

Figure 3 presents the first page of personal data form as found in the archives of PAS. One can see Roman's picture and this is how he is remembered from that time.

Let me in the final words mention how I remember Prof. Teisseyre. He was a man of outstanding intelligence capturing the most important issues even from beyond his area of expertise. Discussions of scientific matters with him were tough since he understood more than most of his interlocutors. He was also a man of generosity, a fantastic comrade with absolutely fantastic sense of humor, and, as mentioned before, an extraordinary scientist. His spontaneous kindness to others, unheard-of honesty and modesty were what made him unique. Knowing him was a great privilege!

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Professor Roman Teisseyre – Honorary Doctor of AGH University of Science and Technology, Kraków, Poland, December 2004

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Senate of the AGH University of Science and Technology, Kraków, Poland, upon the request of the Faculty of the Geology Geophysics and Environmental Protection, conferred the dignity of the Honorary Doctor of AGH UST for Professor Roman Teisseyre on the 7 December 2004. Prof. Dr. Jerzy Kowalczuk (AGH UST) was the promotor of the Honorary Doctorate, two reviewers were: Prof. Dr. Marek Grad (University of Warsaw) and Prof. Dr. Wacław Zuberek (University of Silesia). Professor Jerzy Kowalczuk was very grateful to the AGH UST Senate to entrust him with the laudation, i.e. the presentation of the Candidate. More than one hundred participants took place in the presentation: AGH UST Senate members with His Magnificence Rector Prof. Dr. Ryszard Tadeusiewicz, family members, colleagues from the Institute of Geophysics of the Polish Academy of Sciences (IG PAS), ordinary members and corresponding members of the Polish Academy of Sciences, co-workers from various scientific institutions, students and friends of the Professor and his family, and members of staff of the Faculty of Geology Geophysics and Environmental Protection at the AGH UST with then Dean – Prof. Dr. Tadeusz Słomka and, notably, the members of the Department of Geophysics which were the hosting institutions (Figs. 1–3).

The laudation of Prof. Kowalczuk was published in the journal *Geology* (Kowalczuk 2004). The same issue contained the Master Lecture of the Honorary Doctor (Teisseyre 2004). Some information about Prof. Roman Teisseyre presented here was taken from the above-mentioned laudation. Professor Kowalczuk mentioned that although the Senate members had the opportunity to be acquainted with the opinions of two Reviewers and knew almost all facts from Professor's scientific life, his duty and simultaneously great pleasure was to list once more the arguments for giving the highest academic distinction to Prof. Roman Teisseyre. The first argument was his high scientific position and authority, which was built throughout his whole life by hard work, intellectual abilities, and scientific skills (Kowalczuk 2002). Professor Kowalczuk with emotion underlined that his friendship with Roman Teisseyre lasted since 2004, i.e., for about 60 years! They met for the first time in the Lower Silesia area, where Prof. Henryk Orkisz, at that time a member of staff of the Polish Geological Institute in Warsaw, led

Fig. 1. Prof. Roman Teisseyre – Honorary Doctor of AGH University of Science and Technology, Kraków, Poland.

the geophysical-magnetic investigations in Kłodzko, Poland. At that moment Prof. Roman Teisseyre was a student of the Mathematical-Physical-Chemical Faculty of Warsaw University and Prof. Jerzy Kowalczuk was a young adept of the applied geophysics at the Geological-Surveying Faculty of the Mining Academy, then the Academy of Mining and Metallurgy, and now – the AGH UST. Both young men, learning then geophysical craft, were full of optimistic thoughts about their future with geophysics as their scientific discipline and goal.

In his laudation, Prof. Kowalczuk reached into the history of the Teisseyre family at the end of the XVIII century, when they left France and through Vienna came to Kraków and settled down there. In Prof. Kowalczuk's opinion, the history of the family and deep teaching and scientific traditions influenced the Roman Teisseyre's interests. Discussing the history of the

Fig. 2. At the beginning of the Honorary Doctorate celebration, the Choir of the Song and Dance Group "Krakus" sang the hymn Gaude Mater Poloniae, and at the end – the Gaudeamus.

Teisseyre family Prof. Kowalczuk deeply analysed Warzyniec Teisseyre's geological achievements from the end of the XIX century and finished on the Teisseyre–Tornquist line/zone (TTZ) named for the memory of the Swedish magnetolog A.J.H. Tornquist and Wawrzyniec Teisseyre. The TTZ, a fault boundary between the East European Platform and geological structures of Western Europe was and still is the area of geophysical investigations led by international and Polish scientific groups, which involve the staff of the Institute of Geophysics, Polish Academy of Sciences (IG PAS). Wawrzyniec Teisseyre was the grandfather of the Honorary Doctor – Professor Roman Teisseyre.

Scientific curriculum vitae of Prof. Roman Teisseyre is the subject of other articles in this monograph, so we will not repeat the long list of his outstanding achievements. We only want to mention, after Prof. Kowalczuk's laudation, that Roman Teisseyre had the unique opportunity to work as the assistant of the famous geophysicist Prof. Edward Stenz (Chair of Geophysics, Warsaw University) and famous physicist Prof. Leopold Infeld (Institute of Theoretical Physics at the same university). From the academic duty, we would like to underline that Prof. Roman Teisseyre in his rich scientific career not only worked as an academic teacher but was also engaged in making support materials for students, the most important being a co-edition of the carefully prepared script from Prof. Infeld's lectures, published under the title *Theoretical Electrodynamics* by Polish Scientific Publishers (Suffczyński et al. 1953). Worth mentioning are also the educational materials prepared for the needs of the Geophysical Prospecting Enterprise (Przedsiębiorstwo Poszukiwań Geofizycznych), where he served as a consultant for interpreting geoelectric measurements, and the issue dedicated to Japanese students who attended his lectures on the mechanisms of earthquakes he delivered in Japan in 1965 (Kowalczuk 2004).

Fig. 3. Gratulations in the Main Hall of the AGH UST; Prof. Roman Teisseyre together with H.M. Rector of AGH UST Prof. Ryszard Tadeusiewicz (the first on the right), next Prof. Kaja Pietsch, and Prof. Adam Gawin.

Professor Roman Teisseyre was first of all a theoretician and the majority of his works concerned the physics of the Earth's interior, but among his academic achievements, there were also application works. We want to underline some of such works. Prof. Roman Teisseyre initiated the modern seismological observations in mining and was in that area a continuator of the works of Profs. K. Mainka and E.W. Janczewski. In his laudation, Prof. Kowalczuk mentioned the first such works implemented in the Miechowice mine in Bytom, Upper Silesia, Poland, in the sixties. The model developed, including the non-shearing mechanism of the mining shock source, explained the physical processes of the orogen destruction and confirmed the experimental results. Apart from practical works focused on organizing the seismic works in the Polish mining basins, Prof. Roman Teisseyre was also involved in the international investigations of electromagnetic precursors of earthquakes which have distinct utilitarian aspects.

The important parts of Prof. Roman Teisseyre's works were the training and promotion of academic staff. Many young adepts of applied geophysics at the Faculty of Geological Prospection at the Academy of Mining and Metallurgy, then the Faculty of Geology, Geophysics, and Environmental Protection, AGH UST, enjoyed the positive reviews from Prof. Roman Teisseyre in their doctoral dissertation or habilitation procedures. The authors of the present article also belong to those groups. In the tables below there are presented the lists of 39 persons for whom the Professor prepared the positive reviews for their doctoral dissertation, in habilitation procedures and conferring the title of professor carried out at the AGH UST in the period of 30 years: 1962–1992. Reviews were ordered by the Faculty Council of the Faculty of Geological Prospecting, then the Faculty of Geology, Geophysics, and

Environmental Protection, AGH UST. The titles were conferred in the technical sciences field and the Earth sciences field. Procedures were carried out at the AGH UST for members of the scientific staff of AGH University, the IG PAS, the Oil and Gas Institute, Polish Geological Institute, the University of Wrocław, and Kraków Technical University. Reviews were substantive, short, and focused on the main problems presented by candidates. There were no redundant words, no empty words, only important arguments but from each page the friendly attitude of the Reviewer to a Candidate was visible. Some of the outstanding geophysicists whose works were reviewed by Prof. Roman Teisseyre, e.g. Prof. Adam M. Dziewoński or Prof. Andrzej Kijko, continued their scientific career out of Poland. Prof. Roman Ney, an outstanding petroleum geologist, and the former Rector of AGH, was the founder of the Mineral and Energy Economy Institute, PAS, Kraków, Poland, where he continued his scientific career (Tables 1–3).

Table 1
Reviews in the doctoral dissertations

	Forename and name	University, Institute, Enterprise	Date of conferring a doctoral degree
1	M.Sc. Sławomir Gibowicz	Institute of Geophysics PAS, Warsaw, Poland	6 October 1962
2	M.Sc. Eng. Zygmunt Śliwiński	AGH, Polish Oil and Gas Company, Warsaw, Poland	25 March 1963
3	M.Sc. Eng. Jerzy Kowalczuk	AGH UST, Kraków, Poland	9 March 1964
4	M.Sc. Eng. Zbigniew Jaszczewski	University of Wrocław	21 December 1964
5	M.Sc. Eng. Juliusz Miecznik	AGH UST, Kraków, Poland	22 February 1965
6	M.Sc. Adam Dziewoński	Institute of Geophysics PAS, Warsaw, Poland; Harvard University, USA	15 March 1965
7	M.Sc. Andrzej Pepel	Geophysical Investigations Enterprise, Warsaw; Polish Geological Institute, Warsaw, Poland	28 June 1965
8	M.Sc. Jerzy Jankowski	Institute of Geophysics PAS, Warsaw, Poland	6 September 1965
9	M.Sc. Janusz Łaski	Oil and Gas Institute, Kraków, Poland	13 December 1965
10	M.Sc. Eng. Teresa Grabowska	AGH UST, Kraków, Poland	26 February 1968
11	M.Sc. Eng. Andrzej Kostecki	Oil and Gas Institute, Kraków, Poland	4 November 1968
12	M.Sc. Eng. Marek Lemberger	AGH UST, Kraków, Poland	30 June 1969
13	M.Sc. Eng. Bogdan Cianciara	AGH UST, Kraków, Poland	17 May 1971
14	M.Sc. Eng. Kaja Pietsch	AGH UST, Kraków, Poland	28 June 1971
15	M.Sc. Eng. Halina Jędrzejowska	Oil and Gas Institute, Kraków, Poland	3 June 1974
16	M.Sc. Eng. Maria Bała	AGH UST, Kraków, Poland	26 April 1973
17	M.Sc. Eng. Andrzej Marchewka	AGH UST, Kraków, Poland	20 September 1972
18	Eng. Czesław Twardowski		1 February 1971

Table 2
Reviews in the habilitation procedure

	Forename and name	University, Institute, Enterprise	Year of conferring a habilitation degree
1	Ph.D. Eng. Maria Bała	AGH UST, Kraków, Poland	1990
2	Ph.D. Eng. Maria Ciechanowska	Oil and Gas Institute, Kraków, Poland	1990
3	Ph.D. Jan Dzwinel	Oil and Gas Institute, Kraków, Poland	1969
4	Ph.D. Sławomir Gibowicz	Institute of Geophysics PAS, Warsaw, Poland	1976
5	Ph.D. Eng. Adam Gawin	AGH UST, Kraków, Poland	1971
6	Assoc. Prof. Ph.D. Aleksander Guterch	Institute of Geophysics PAS, Warsaw, Poland	1978
7	Ph.D. Eng. Wojciech Górecki	AGH UST, Kraków, Poland	1979
8	Ph.D. Eng. Jadwiga Jarzyna	AGH UST, Kraków, Poland	1990
9	Ph.D. Eng. Andrzej Kostecki	Oil and Gas Institute, Kraków, Poland	1971
10	Ph.D. Andrzej Kijko	Institute of Geophysics PAS, Warsaw, Poland; University of Pretoria, South Africa	1978
11	Ph.D. Eng. Marek Lemberger	AGH UST, Kraków, Poland	1991
12	Ph.D. Eng. Juliusz Miecznik	AGH UST, Kraków, Poland	1970
13	Ph.D. Adam Cichy	AGH UST, Kraków, Poland	1993

Table 3
Reviews for conferring the title of professor

	Forename and name	University, Institute, Enterprise	Year of conferring a the title of professor
1	Assoc. Prof. Dr. Eng. Zbigniew Fajklewicz	AGH UST, Kraków, Poland	1973
2	Assoc. Prof. Dr. Eng. Teresa Grabowska	AGH UST, Kraków, Poland	1987
3	Assoc. Prof. Dr. Eng. Stanisław Małoszewski	AGH UST, Kraków, Poland	1969
4	Assoc. Prof. Dr. Eng. Henryk Marcak	AGH UST, Kraków, Poland	1988
5	Assoc. Prof. Dr. Eng. Roman Ney	AGH UST, Kraków, Poland; Mineral and Energy Economy Institute, PAS, Kraków, Poland	1971
6	Assoc. Prof. Dr. Henryk Orkisz	AGH UST, Kraków, Poland	1969
7	Dr hab. Eng. Kaja Pietsch	AGH UST, Kraków, Poland	1999
8	Dr hab. Eng. Edward Szaraniec	Kraków University of Technology	1992

The table was compiled by Mrs. Urszula Godyń, Dean's Office at the Faculty of Geology Geophysics and Environmental Protection, AGH UST.

Fot. 4. Contemporary photo of the deformation of the monument; earthquake in Tulbagh-Ceres, South Africa, 29 September 1969 (after R. Teisseyre's Master Lecture).

The Master Lecture presented by the Honorary Doctor of AGH UST, Prof. Roman Teisseyre, at the celebration of conferring the dignity was entitled "Seismic Rotational Effects". It was divided into parts comprising the following issues: Observation of the macroseismic effects – classic examples; Construction of the rotational seismographs; Rotational waves – theoretical considerations; The first seismogram of the rotational waves; The modern systems for rotation field registration: examples; Source of rotation waves and problems of their propagation; Microseismic fields vs. effects in macroscale – engineering seismology; Open problems. Professor illustrated his lecture with many schemes and plots to show the listeners how complicated the problem is, which troubled him for all his life. An example of monument deformation is shown in Fig. 4.

The authoresses of this article, geophysicists belonging to the staff of the AGH University of Science and Technology, Kraków, Poland, are very proud and happy that the dignity of the Honorary Doctor of our University had been conferred to the excellent scientist, geophysicist known all over the world – Professor Roman Teisseyre.

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Roman Teisseyre as an Author and Editor

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As a language and managing editor of the publications issued by the Institute of Geophysics for the last forty years, I feel obliged to write a few words about my work with Roman, our most prolific author. He was my very good and reliable friend, and I experienced a lot of good from him during my whole work at the Institute.

In terms of pure facts, Roman Teisseyre was an author or co-author of over 250 papers and wrote or edited a number of multi-volume, unique monographs, related to the variety of physical processes acting on and within our Earth. Yet his real role and his merits for the development of the Institute's publishing activity were much greater. He was a spiritus movens of organizing modern editorial offices and kept encouraging his colleagues and students to write, understanding the necessity of sharing our achievements worldwide.

His first geophysical paper appeared in *Acta Geophysica Polonica* already in Number 1, 1953. In the early years of this journal, he probably was the most frequent author, acquiring the position of Editor-in-Chief in 1995 and keeping it until 2005.

Alongside, with full energy, Roman reorganized other publications of the Institute, which had been appearing under various titles. In 1963 he gathered all of them and created an ample series *Materiały i Prace Zakładu Geofizyki PAN*, covering the results from observatories, original scientific papers, selected habilitation treatises, selected doctoral theses, conference materials, and the like. In 1973 its name was translated into English, *Publications of the Institute of Geophysics, Polish Academy of Sciences*, and it's how it appears up to now. After some years, this series drew the attention of Springer Verlag and opened our cooperation with this publisher; we were asked to transform part of it into Springer's book series, which gave birth to the *GeoPlanet Book Series*. Roman was a member of its Editorial Board until his death and a co-editor of two books.

Roman highly valued monographs, books treating some specific problems in a comprehensive way, from various points of view. In 1983 he edited a 2-volume monograph in the Polish language ("Fizyka i Ewolucja Wnętrza Ziemi"), issued by Polish Scientific Publishers PWN, and then, in the years 1984–1993, he co-edited the monumental 6-volume monograph "Physics and Evolution of the Earth's Interior", issued by PWN-Warszawa, Elsevier-Amsterdam, Oxford, New York.

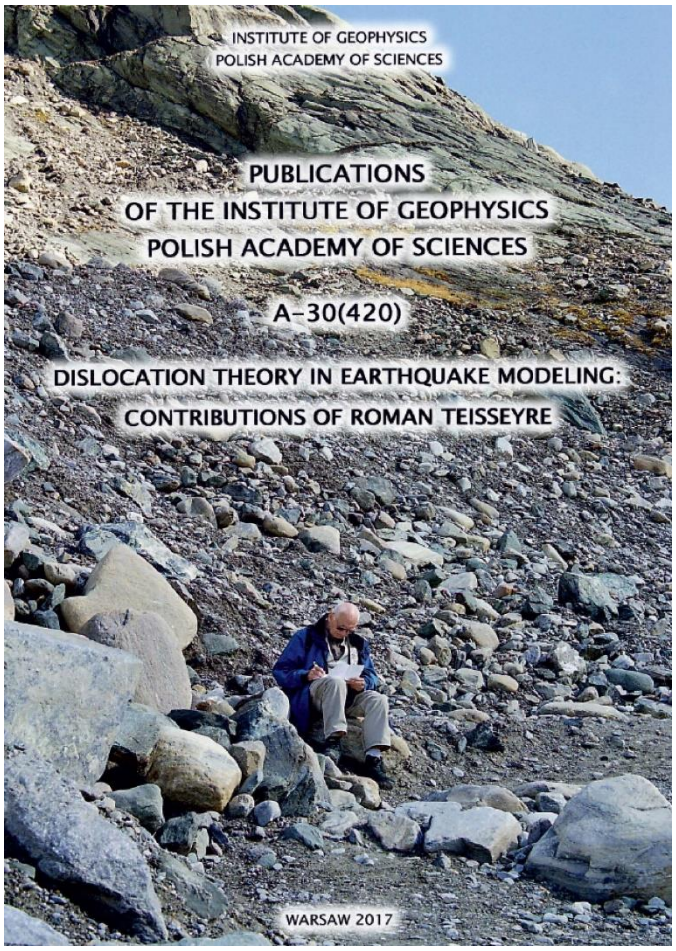

Fig. 1. Cover of the issue with Roman's major contributions to the development of dislocation theory.

Roman was one of the pioneers of applying the dislocation theory in geophysics. Therefore, in 2017 we decided to republish his major publications of the years 1961–1990, the milestones in the consecutive stages of the development of the theory of earthquake premonitory and fracture processes, scattered over various journals and books (front cover in Fig. 1). This issue also contains an outline of Roman's plans for further work; he wrote: "I am currently working on further developments of the Asymmetric Continuum Theory with the shear and rotation strains and include the quantum processes. I am taking into account doublet continua with the elasticity and time rate plasticity, using a special definition of plasticity. I am also trying to include, as an important counterpart, the electric and magnetic fields". Unfortunately, he was unable to realize his plans because of a serious illness.

For copy editors, Roman was a difficult author, since it was not easy to follow his reasoning and his amazing command over sophisticated formulae. His brain operated so fast that some explanation seemed too obvious for him. But he gladly accepted all reasonable remarks, treated them with a friendly smile, and we hope his papers were understandable for people truly involved in the studied problems.

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Earth Research – The Tradition in the Teisseyre Family

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The interest of **Professor Roman Teisseyre** in earth sciences and his achievements, broadly described in this book, may have its source in the family tradition – his grandfather Wawrzyniec, uncle Henryk, and cousins Juliusz and Andrzej Karol were all geologists interested in various branches of geological sciences and passionate of field research.

Roman was born in Lwów in a family whose lifestyle was dominated by research passions of his grandfather Wawrzyniec, a well-known geologist. Kazimierz, the third oldest son of Wawrzyniec, and the father of Roman, often participated with his brothers in field research expeditions organised by their father. Reminiscences of these expeditions were likely to be shared by Kazimierz with young Roman.

A significant impact on the development of Roman's interest in earth sciences may also have had his stay in Wrocław, close to the family of his uncle Henryk, who organised geological research in Wrocław and Polish exploration of the Sudetes after World War II.

Roman, together with his mother and sister Izabela came to Wrocław in 1947, after having traveled a long and complicated way by Kraków and Jelenia Góra. The family shared an apartment on today's Pereca Square in Wrocław. Roman attended the First High School in Wrocław on today's Poniatowskiego Street, where he got a high school diploma by the end of 1940s. Then, he studied physics at the Faculty of Mathematics, Physics and Chemistry at the University in Wrocław, before finally moving to Warsaw. As a student, he often participated in field research expeditions in the Sudetes, organised by his uncle Henryk for geology students. The time spent in Wrocław is always recalled by Roman very warmly. During his visits to this city, he often re-visited places he had remembered from his youth: the tenement house on Pereca Square, the high school building, and the Saint Elisabeth Church, he went to on Sundays, where Holy Masses were still celebrated by German priests until the end of 1940s.

Following the family tradition, Roman transmitted his passion for geosciences to one of his two sons, Krzysztof, who, although started his professional work as a biologist, soon turned part of his interests into geophysics.

How the Teisseyre family settled in Poland

The Teisseyres are a family with French roots, with a long and complicated history. The family tradition connects the family roots with the environs of Toulouse, a big city in south-western France. As a protoplast of the family, Armand Tesseyre (according to the spelling in the Middle Ages) is considered. He worked as a rural teacher and a medical doctor in a small

village and was a member of a religious movement of the Cathars. The protoplast of the Polish branch of this family was Louis Stanislaw de Teisseyre, the son of a captain of the guard of a younger brother of the French king Louis XVI, who then became the French king Louis XVIII, and a French noble, Maria Bonnal de Ganges.

Louis Stanislaw was born in 1789, the year of outbreak of the Great French Revolution, which changed the history of the family. Louis de Teisseyre, the father of Louis Stanislaw, who was a declared "royalist" (a person who supported the overthrown king Louis XVI), was killed by revolutionists. The only keepsake saved from this time is a wool armband with three royal bourbon lilies sawn by a silver thread and the inscription: Fidelite et Constance Pour Dieu et Roi ("Constancy and Faithfulness to God and King") (Fig. 1). The four-year-old son Louis Stanislaw with his mother had to escape from the terror of the Revolution. With a group of French refugees, they came to Vienna in Austria and finally to Kraków (which was part of Austria at that time), where they settled around 1795. Maria had not married again; she lived and provided education to her son using the money she got from selling the goods she had brought from France. She also got support from Polish princess de Ligne-Potocka, with whom she was a friend even before the French Revolution.

Fig. 1. The wool band that was worn during the French Revolution, probably till 1793, by Louis de Teisseyre (Roman's grand-grand-grand-grandfather).

Louis Stanislaw completed studies at the Jagiellonian University in Kraków, receiving the title of magister scholarum (school teacher) in French language. The teacher's job was a source of support for him and his family. He was married to Maria Hladik of Czech nationality, and they got eight children. In order to be able to support such a large family, he had to move from one city in Galicia to another, looking for a well-paid job as a teacher of French. Finally, in 1837 he was employed as a Professor at the High School in Brody (today in Ukraine). He died in this city in 1841 and was buried there.

Out of his eight children, only the third oldest son, Henryk, got a large family of ten kids. Henryk is remembered in the history of the family Teisseyre as an extraordinary person, who played a predominating role in its later history (Fig. 2). He was born in 1826 in Wieliczka (a small city close to Kraków). Skillful, early got used to hard and independent work, and in 1844 he became a student at the Technical Department of the Imperial Technical Academy in Lwów (in 1844–1877 it was the name of the later Technical University in Lwów). He studied railway construction engineering. In 1848 he participated in the People's Spring Revolution as a mem

Fig. 2. Henryk Teisseyre – Roman's grand-grandfather.

ber of an Academic Legion of the National Guard. As a punishment for participation in the Revolution, he had to join the Austrian army for long-term service. Thanks to his proficiency as a railway engineer and fluency in German and French, he was given the chance to terminate the military service already after eight years as an officer of engineering. He designed and supervised the construction of railway tracks in central and northern Galicia, among others, of the railway line Lwów–Tarnów. Then he got married. His first wife was Julia de Belina Węgierska, with whom he had got six children. Among this outspring there was Wawrzyniec, who later became a world-famous geologist, protoplast of the „geological line" in the family Teisseyre. Taking into account Henryk's job, the family had to frequently move from town to town in Galicia (Wieliczka, Tarnopol, Kraków, Lwów).

Henryk died in 1900. He was buried in the Łyczaków Cemetery in Lwów, in a family tomb. The tomb is preserved until now and it is under the care of descendants of Henryk Teisseyre, living in Warsaw and Wrocław.

The geological line

Wawrzyniec, actually Karol Wawrzyniec, was the third oldest child of Henryk, born in 1860 in Kraków. He was eight years old when his mother died. Because the family had to frequently move from town to town, he attended schools in different cities: Kraków, Lwów, and finally Tarnopol (today in Ukraine), where he got the high school diploma in 1878. At the age of 19, he started studies at the Imperial-Royal University in Vienna and, almost at the same time, at the Mining Academy in Loeben (Austria). In the preserved document of the „absolutorium" (promotion), received in 1882 at the Faculty of Philosophy at the University of Vienna, there are enlisted lectures given by the most famous geologists of that time, including Eduard Suess (tectonics), Melchior Neumayr (paleontology), and Gustav Tschernak (mineralogy). At the same time, he started to work at the Imperial-Royal Institute of Geology in Vienna.

Having got financial support from this Institute, he went on his first research trip to the Ryazan Governorate (Riazan Gubernia, Russia). The result was his first scientific publication, concerning Jurassic stratigraphy of the Central-Russian Platform. The publication was well-received by the scientific milieu and this acceptance gave a chance for further donations for his next research trips and next publications. In the beginning, there were mostly paleontological works concerning Jurassic ammonites. Some of the ammonite species described by him are holotypes of leading genres for Jurassic deposits of central Russia. The results were published in Polish, German, French, and Russian in prestigious scientific journals in Vienna, Kraków, and Petersburg. At the same time, in order to deepen his knowledge and get more financial support, he worked at the Department of Mineralogy of the Jagiellonian University, headed by an outstanding mineralogist, Alois Alth. After the death of the mentor, he worked on documentation of paleontological collections at the Courtly Museum of Natural History in Vienna. Skillful, hardworking, and universally educated, he got recognition and academic degrees very soon. At the age of 26, he defended PhD thesis at the Imperial-Royal University in Vienna. The thesis was about Jurassic cephalopods from the Ryazan Governorate in Russia. Already as a young PhD holder, he was admitted to the Vienna Society for Support of Natural Exploration of the East. At the same time, he started cooperation with the Physiographic Commission of the Academy of Learning in Kraków. In 1887 the Commission-donated works on preparation of the Geological Atlas of Galicia, a unique enterprise, were started. Preparation of the map sheets was entrusted to the best geologists-cartographers. Among them was Wawrzyniec, who prepared, within the period from 1886 to 1890, dozens of geological maps together with descriptions, of the eastern part of the Galicia's district Podole.

Wawrzyniec received his habilitation degree from the Jan Kazimierz University in Lwów twice. In 1891 his thesis concerned paleontological matters, and then, in 1907, it was supplemented by general geology results following from geological research done in the Romanian Carpathians. As a recognition for outstanding research works he was awarded by the Śniadecki Fellowship donated by the Academy of Learning. This financial support enabled him to make a scientific trip to France, Germany, Austria, and Switzerland.

After the end of this trip, on the invitation of the Royal Government of Romania, Wawrzyniec joined the investigations of the Tertiary oil-salt formation in Romanian Carpathians, working, for 15 years (until 1910), as an oil geologist and being member of the Research Commission of the Romanian Institute of Geology. He prepared, e.g., geological maps of Moldavia and Wallachia. Simultaneously, he worked on biostratigraphy of the Tertiary, preparing and publishing the first extensive monograph of mollusks of Neogene of Romania, which belongs to basic research works in this area.

At the end of the contract, as a recognition for his accomplishments in the Tertiary research and contribution to the discovery of oil resources in Romania, Wawrzyniec was awarded the

highest state decoration of this country – Officer Order of the Romanian Crown, conferred by King Charles I.

In 1901, in Lwów, Wawrzyniec married Janina Polityńska. The successful marriage gave life to five sons, born between 1902 and 1911 in Lwów; Jerzy, Henryk, Kazimierz (Roman's father), Stanisław, and Andrzej (Fig. 3). All the sons of Janina and Wawrzyniec completed studies at universities in Lwów, choosing various faculties.

Fig. 3. The photo of the family Teisseyre taken in Lwów. Sitting from left to right are Wawrzyniec's sons: Kazimierz (Roman's father), Jerzy, Henryk, Stanisław. Standing behind the children are: Maria (Wawrzyniec's sister) and Wawrzyniec (Roman's grandfather).

In Lwów, starting from 1910, simultaneously with field research work, Wawrzyniec hold the position of full professor, and has been teachings. Firstly, in the Department of Philosophy of the Jan Kazimierz University, he was giving lectures on geology and paleontology. Then, from 1924 until the end of his job activities in the late 1930s, he was associated with the Faculty of Water and Land Engineering at the Technical University in Lwów.

During the first years of independent Poland, Wawrzyniec, as a vice-director of the Polish State Institute of Geology, made a tremendous effort to establish regulations and co-ordination of geological works and to prepare a programme of an organisation of geological works on the territory of the reborn country. General principles and regulations of this programme remain obligatory until today.

The first two decades of the XXth century were a time of Wawrzyniec's intense work on the tectonics of the Carpathians and the Podolian plate. It was the time when his everlasting publications were written, ahead of some currently accepted tectonic concepts concerning the geology of the Podolian plate and the influence of its tectonics on the development of the Carpathian orogeny. He gave proof for the existence of a fault structure of the periphery of the Podolian plate, which he named the „Schody Przypodolskie" ("Stairs next to Podole"). He connected the origin of these "stairs" and their direction with other important, previously discovered, tectonic lines of Europe. Among them was one of the most important structural lines, previously discovered by Alexander Tornquist. The southeastern part of this structure was called by Wawrzyniec "the main line of external rims of Neocarpathian hollow of the Lesser Poland". Nowadays this line is called the Teisseyre–Tornquist line (T–T line).

The scientific achievements of Wawrzyniec were recognised by the scientific milieu. In response to an application of the Senate of Technical University in Lwów, in 1935 the President of Poland, Ignacy Mościcki, conferred to Wawrzyniec Teisseyre the title of an Honorary Professor of this University. He was also an honorary member of many scientific and industrial societies and awarded numerous medals, among them the Commander Cross of the "Polonia Restituta" ("Restored Poland") Medal conferred to Wawrzyniec for "an outstanding scientific work". Wawrzyniec died in Lwów on the 2 April 1939. He was buried on the Łyczaków Cemetery in the family tomb, next to his father, Henryk.

His publications, saved from destruction during World War II, were transported from Lwów to Wrocław at the end of the war by his son, Henryk. After being catalogued and preserved from damage, they were given by the Teisseyre family to the Archives of the University in Wrocław in 1996. Some publications written by Wawrzyniec concerning studies and development of concepts on tectonics of the Podolian Plate and the Carpathians with their foreland were known to Roman, as well as publications written by his son, Henryk, containing results on studies on the tectonic evolution of the Sudetes. More about Wawrzyniec Teisseyre in: Teisseyre B. (1998a).

Henryk Jan Juliusz, the second oldest son of Wawrzyniec, inherited the interest in earth sciences from his father. He was born on the 21 March 1903 in Lwów. Henryk began his studies in 1922 at the Department of Chemistry at the Technical University in Lwów. Then he continued studies at the Jan Kazimierz University in Lwów, at two faculties: mathematics-natural sciences (geographic subjects) and philosophy (geological sciences). Yet as a student he became an assistant at the Department of Geography, headed by a world-famous Polish geographer, Professor Eugeniusz Romer. In 1928 he received a Doctor of Philosophy (PhD) title in geography, after having defended the thesis entitled "Top surface of the Carpathians". At this time, he went to Lausanne in Switzerland to deepen his scientific knowledge by studying geology at the university there. His mentor was Professor Maurice Lugeon, a world-famous specialist in tectonics, who created a theory of the nappe structure of the Alps.

Henryk's love for field research and financial needs of his family made him work, for the next 10 years, as an oil geologist preparing excellent geological maps for the well-developing Polish oil industry in the Eastern Carpathians. This work resulted in his habilitation in general geology at the Jagiellonian University in Kraków, in 1936. Then, as an associate Professor, he has given lectures on tectonics. In 1938 he habilitated for the second time at the Jan Kazimierz University in Lwów. This time his topic was the tectonics of the Carpathians and Podole.

The World War II came to Henryk at the time when he started his great scientific achievements. After the war, in March 1945, Henryk and his family left Lwów and Eastern Carpathians forever and became a war refugee. He went to Kraków, then to Poznań before he finally settled in Wrocław. In the spring of 1946, he got an invitation from the Rector of the University and Technical University in Wrocław, Professor Stanisław Kulczyński, to start, since the 1 March this year, the "service at the University and Technical University in Wrocław, at the Department of Natural Sciences". Henryk accepted the invitation and continued the "service" at the University for the next 29 years, until his death in 1975.

Henryk Teisseyre was an initiator of the Polish geological exploration of the Sudetes and systematic geological studies of this area. He also was a co-author of a curriculum for geological studies at the University in Wrocław, a founder of the Lower Silesian Branch of the Polish Geological Institute, a creator of the "Wrocław geological school" in the area of structural geology and a mentor for many famous scientists and university professors in Wrocław.

He also led intensive field research, making excellent geological maps of various parts of the Sudetes. In field research, he was always accompanied by his wife, Julia, in many cases also by their two sons, Juliusz and Andrzej Karol, and by groups of university students, including Roman.

Among many decorations that were conferred to Henryk, there was the highest one that can be given by a University – the Honoris Causa Doctorate (Honorary Doctorate) of the University in Wrocław, conferred as an appreciation of his "outstanding achievements in research, teaching, and organisation".

Professor Henryk Teisseyre died on the 29 October 1975 in Wrocław. He is buried in a family tomb at the Grabiszyński Cemetery in Wrocław. More about Henryk Teisseyre in: Teisseyre (1998b).

Juliusz (1933–1991) and **Andrzej** Karol (1938–1991) were sons of Henryk and cousins of Roman, cordially friendly to him. They both continued geological tradition of the Teisseyre family. Born in Lwów, they graduated from the geological faculty at the University in Wrocław in the early 1960s. They performed their research mostly in the Sudetes.

After graduation, Juliusz moved to Warsaw, where he worked in the Laboratory of Petrography at the Department of Geological Sciences, Polish Academy of Sciences. He accomplished the PhD and the habilitation degrees there. The main topic of his research was the tectonics and genesis of metamorphic rocks of the sheath of granite in the Karkonosze mountains (the highest part of the Sudetes). Juliusz died in 1991 and was buried at the cemetery in Turku, Finland, where he lived over the last years of his life.

Contrary to Juliusz, his younger brother Andrzej Karol Teisseyre remained in Wrocław and associated his professional life with the Institute of Geological Sciences at the University. The topics of his geological works evolved over time. His PhD thesis and habilitation were about the sedimentological characteristics of sedimentary rocks and paleogeography of the Lower Carboniferous in the Sudetes. For the rest of his short life, he focused on observations of sedimentological and erosive processes in riverbeds and floodplains of current small mountain rivers in the Sudetes. Cycles of his monographic publications on these topics gave grounds for

conferring him the title of full professor at the University of Wrocław. Similarly to his grandfather and father, Andrzej Karol also actively participated in the process of education of young geologists. He was one of the best university lecturers in geological sciences at that time.

Andrzej Karol died in 1991 in Wrocław. He is buried in the family tomb, next to his father and mother, at the Grabiszyński Cemetery in Wrocław.

Translated from Polish by Andrzej Robert Teisseyre

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Physicist in Search of the Theory of Earthquakes

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A b s t r a c t

Earthquake prediction is often considered the Holy Grail of seismology and earthquake science. However, earthquake research can be motivated both by challenge, when asking about seismic risk or hazard, or how lives could be saved, and by curiosity, when asking about the physics behind the observed patterns of seismicity. In this brief review, I focus on the second, cognitive aspect of earthquake science. I wonder how interesting seismicity and earthquake physics can be for a theoretical physicist turned seismologist.

1. INTRODUCTION

A physicist looks at the world through the prism of concepts such as momentum, energy, field, interactions, waves, entropy or probabilities, and instabilities. A geophysicist describes the Earth and the elements of its system, such as the geosphere, hydrosphere, cryosphere, atmosphere, or near-terrestrial space, in this way. A physicist turned seismologist applies the same tools of physics to study seismicity, earthquakes, and related processes.

There is no fundamental theory of earthquakes, such as the theory of electrodynamics or gravitation. There is a collage of diversity: specific models, concepts, or observations. Elastic rebound, earthquake cycle, slow and fast slips on faults, scaling relations, seismic moment budget, radiated seismic energy, stress trigger and shadow, slip deficit, and missing moment are the terms that we need to know to get some insight into the earthquake science. Thus, the earthquake science is more like the theory of turbulence, which remains 'the last unsolved problem of classical physics', though many of its specific problems have been well understood (Falkovich and Sreenivasan 2006). Understanding earthquakes and getting a consistent view on seismicity means putting all the pieces of the earthshaking jigsaw puzzle together (Hough 2002).

Mentioning that, which I believe is true, I start to think about Roman Teisseyre. I see him sitting at his desk and writing mathematical equations on a sheet of paper or making notes on a copy of a published research article. The search for a fundamental theory of earthquakes, similar to the theory of electrodynamics or gravitation, seems to be the main feature of his approach to his research, his Holy Grail of earthquake science. A physicist in search of the theory of

earthquakes is how I remember him as a scientist, or as a theoretical physicist who became a seismologist.

2. SEISMOLOGY AND THEORETICAL PHYSICS

Gravitation. Einstein's theory of gravitation, or General Relativity, is based on the Einstein field equation, $\boldsymbol{G} = 8\pi\boldsymbol{T}$, where $\boldsymbol{G}$ is the Einstein tensor representing the space-time curvature, which can be expressed as a nonlinear function of the metric tensor, and $\boldsymbol{T}$ is the stress-energy tensor of the matter. Thus, the Einstein equation relates space-time geometry to the stress-energy of the matter (Misner et al. 1973). According to this view of the Universe, space-time is no longer merely a stage for events. On the one hand, matter and energy curve the space. On the other hand, the curvature of space determines the movement of matter and energy. Although this equation seems simple, it is in fact a complex system of non-linear differential equations with a wealth of applications and consequences. It governs the motions of luminous galaxies and dark matter, the evolution of the large-scale structure of matter in the Universe, and the geometry of spacetime, including instabilities, singularities, and gravitational waves caused by moving matter. By adding a term with the cosmological constant to the field equation, $\lambda\boldsymbol{g}$, where $\boldsymbol{g}$ is the metric tensor, you can account for dark energy in the Universe.

Earthquake physics is based on continuum mechanics, to which a similar geometrical approach can be applied, with the incompatibility law, $\boldsymbol{R} = \boldsymbol{S}$, playing the role of Einstein's field equation. Here, $\boldsymbol{R}$ represents the space curvature and $\boldsymbol{S}$ represents the sources of elastic strains and internal stresses in the medium (Kröner 1981). Dislocations or other defects, modelled as non-elastic or plastic, stress-free deformations within an elastic medium, play a similar role as matter in the theory of gravity, i.e., as sources of deformations and changes in the geometry of the medium. Since earthquake sources can be modelled as dislocation distributions, this view enables us to explain the deeper meaning of the seismic moment tensor, as well as interactions between tectonic faults, where a slip in one place can cause another slip in a distant place; or interactions among earthquakes, which can be treated as slip events on faults (see Appendix). Such a perspective allows the physicist to develop the theory of complex earthquake sources using similar mathematical tools, physical concepts, and intuitions, as has been done in the case of the theory of gravitation or other theories of physics, including electrodynamics.

Electrodynamics. We describe the electromagnetic field using the four quantities: electric field strength, $\boldsymbol{E}$, electric field induction, $\boldsymbol{D}$, magnetic field strength, $\boldsymbol{H}$, and magnetic field induction, $\boldsymbol{B}$. Electric charge density, $\boldsymbol{\rho}$, and electric current density, $\boldsymbol{J}$, describe the sources of the electromagnetic field and their motion. Maxwell's equations of the electromagnetic field determine the relationships between the quantities describing this field and its sources: Gauss' laws for electric and magnetic fields, and Faraday's and Ampère-Øersted's laws for, respectively, electric and magnetic induction (Jackson 1998).

The field equations are supplemented with three material equations characterizing the medium. The first defines the relationship between electric field strength and electric field induction, $\boldsymbol{D} = \varepsilon\boldsymbol{E}$, where ε is electric permittivity. The second defines the relationship between magnetic field strength and magnetic field induction, $\boldsymbol{B} = \mu\boldsymbol{H}$, where μ is the magnetic permeability. The third is Ohm's law, which defines the relationship between electric field strength and current density, $\boldsymbol{J} = \sigma\boldsymbol{E}$, where σ is conductivity. From Maxwell's equations, we obtain the laws of conservation of electric charge and electromagnetic field energy, i.e., the continuity equation and the Poynting equation, respectively.

Earthquake physics is based on elastodynamics, with the stress-free, plastic deformations to model seismic source dynamics (see Appendix). Respective theory can be formulated in analogy to electrodynamics. The stress, $\boldsymbol{\tau}$, stands for the electric field strength, $\boldsymbol{E}$; distortion, $\boldsymbol{\beta}$, stands for the electric field induction, $\boldsymbol{D}$. Displacement velocity, $\boldsymbol{v}$, stands for the magnetic field

strength, $\boldsymbol{H}$, whereas momentum density, $\boldsymbol{w}$, stands for the magnetic field induction, $\boldsymbol{B}$. The field sources are the dislocation density, $\boldsymbol{\alpha}$, and the dislocation current density, $\boldsymbol{\rho}$. The field equations of elastodynamics have the same geometric interpretation as the equations of electrodynamics, including the equivalents of the Poynting equation and Ohm's law, which describe the strain and kinetic energy balance, together with its dissipation during slip (Bovet 1979). Although seismicity is a complex system and cannot be fully described by elastodynamics, its field equations enable us to gain deeper insight into various aspects of earthquake physics, including energy balance and interactions in seismic zones.

Cosmology. Galaxies, consisting of stars and interstellar gas clouds, can be seen with telescopes as "points of light". They are clustered in small and big groups, with hundreds to thousands of members. Such clusters are grouped in superclusters distributed along interconnected walls and filaments surrounding almost empty regions called voids (Martinez and Saar 2001; Gott 2016). The superclusters form a three-dimensional, large-scale structure of the Universe, which can be perceived as a cosmic web, with the richest galaxy clusters concentrated near its nodes. The observed galaxy distribution is the result of gravitational growth of small initial fluctuations or instabilities in the almost uniform early Universe (Peebles 1981).

However, the visible objects in the Universe are regarded as just tracers, or "light maps", of the underlying cosmic matter distribution. The galaxy clusters are above all dense concentrations of the dark matter, which can be detected by its gravitational effects and is thought to account for approximately 85% of the matter in the Universe. One of the objectives of the modern cosmology is to relate the visible objects, both optically and by X-ray observations, to the underlying, actual, mostly dark mass distribution (Borgani and Guzzo 2001).

Seismicity can be viewed in a similar way. The distribution of epicenters of strong earthquakes on the world map marks the boundaries of tectonic plates. Their patterns in specific regions, such as the Japanese subduction zone or the Nepal-Himalayan collision zone, reflect the complex processes underlying earthquake occurrence. For example, when we plot earthquake epicenters along the Japan Trench as circles with their radii related to earthquake source areas, for a given time period, we can recognize a kind of seismic web: a hierarchical structure with some visible voids, where earthquakes less frequently occur, as in the case of the cosmic web. That structure reflects the underlying plate interface physical features, such as asperities, where the plates are coupled stronger, and where higher stresses accumulate due to the plate movements, surrounded by weaker, non-asperity regions. Thus, earthquake sources reflect characteristic, deeper structures at the plate interface, like glowing galaxies reflect the deeper structure of dark matter in the night sky. The challenge is to recognize the nature of these voids: are they places of strong plate bonding, which, when cracked, become the source of strong earthquakes; or, on the contrary, are they places of weak bonding, where the slip is slow, invisible to seismometers.

Turbulence. Turbulence can be defined as a chaotized flow. It can be viewed, therefore, from two different points of view. First, as the flow, it is modelled by the Navier-Stokes equations, which result from Newton's second law applied to the viscous fluid motion and express momentum balance and conservation of mass in hydrodynamics. Second, as the chaotic process, which is irregular in both time and space, it can be described in terms of statistical averages, such as moments of velocity differences with their dependences on spatial scales (Falkovich and Sreenivasan 2006).

Mechanism for the generation of turbulent flows can be considered as an energy cascade. The energy is injected at the largest length scale; it is transferred or cascaded without loss through the intermediate, so-called inertial range of scales, and it is finally dissipated by

viscosity at its characteristic, smallest length scale. Nonlinear effects are responsible for producing a hierarchy of motions on smaller and smaller scales.

The motions of individual particles in a turbulent flow are irregular and unpredictable, but statistical tools enable us to reveal some order, or geometrical and dynamical structures, that occur in such a complex process. They are expressed as statistical conservation laws and scaling relations, which describe how different statistical averages change with scale or size measures.

Seismicity is driven by the slow relative movement of tectonic plates, and the energy thus supplied to the system is released through fast and slow slips along faults, so aseismic creep phenomena, slow slip events, and earthquakes, all of varying sizes and scales.

The earthquake rupture processes can be simulated by using the differential-integral equation, where a slip velocity at a given point on a fault depends on the net stress, so the driving stress caused by the tectonic loading and slips or deformations in the whole medium, minus the frictional stress due to material characteristics of the fault at that point (Senatorski 2019). However, the seismicity models should involve probabilistic principles that reflect our uncertainty about the future earthquakes. By looking at the geodetic and seismic data, it is easy to explain why a given large earthquake did occur at a given time and site, and why its magnitude and other characteristics are as observed, but we do not know those details in advance. What we can only guess are possible scenarios or outcomes. We do not have enough knowledge to predict which of the possible scenarios will be realized, though we do know the constraints they should meet.

Such constraints can be learned from energy budget observations, accumulated and released strains due to, respectively, the tectonic plate movements and earthquakes, or alternatively, slow slip events observed in a given region. They result also from the plate interface characteristics, which are reflected by statistical scaling relations among earthquake parameters, and from our understanding of the relation between the structure and material characteristics of a subduction channel at the plate interface and the plate coupling strength at a given location (Senatorski 2020). We should use all and only available knowledge for the honest and effective forecasts of the largest earthquakes, so that our uncertainty about the system outcome is also taken into account. In a sense, the slippage occurring on a fault can, as in the case of turbulence, be called the chaotized flow; and that is why its modeling should take into account both our knowledge and uncertainty.

3. CONCLUSIONS

Earthquake prediction is often considered the Holy Grail of seismology and earthquake science. However, earthquake studies can be motivated both as a challenge to save lives and by curiosity about earthquake processes. This short review is focused on the second aspect, when we ask about the physics behind the observed seismicity patterns.

Referring to four examples – the theory of gravity, electrodynamics, cosmology, and turbulence – I tried to show that seismology, as a part of geophysics, can and should draw inspiration from even such distant fields of physics. I think that field theory, statistical physics, and astrophysics, along with geophysical observations, were the main inspiration and starting point for Roman Teisseyre's considerations reflected in his books and articles (Teisseyre and Teisseyre-Jeleńska 2014). Among these inspirations, the continuum dislocation theory, briefly discussed in the appendix, played a special role.

Seismicity is a complex system. Seismic networks and space geodesy provides a detailed view of the stress accumulation-release process at the plate interface in seismic zones. This approach has not brought effective earthquake predictions. We hope that new methods of data processing, including machine learning methods, will help to solve the problem. But perhaps we also need more creative and more imaginative theoretical considerations – and perhaps

surprisingly simple solutions – as is the case in other fields of modern physics. What makes the science of earthquakes so fascinating is that its different aspects – cognitive and practical – cannot be separated.

APPENDIX

Earthquakes are understood as processes of fast slips along faults. An earthquake source can be modelled as a plastic deformation within an elastic medium representing the crust of the Earth. Elastic deformations are related to stress by Hook's law. Plastic deformations are stress-free.

Thought experiment. The following procedure can be imagined (Kröner 1981). A macroscopic body is built up of many small-volume elements. Each of the small elements is deformed plastically, so that they do not fit well together. Then, we deform them elastically in such a way that they fit together again. The elastic deformation should be just opposite to the plastic one to do the task. After the elements are welded and the forces responsible for the elastic deformation are removed, the body relaxes into the lowest energy state by a second elastic deformation.

The same procedure can be applied to a finite earthquake source volume and its surroundings. First, we cut out and remove the volume from its neighborhood and deform it plastically. Then, we deform the separated volume elastically so that, when inserted back into its surroundings, it fits into the empty space. When the entire medium relaxes, additional elastic deformation occurs both in the source volume, which was plastically deformed, and outside the source volume, where there was no plastic deformation.

These imagined procedures can be described mathematically by using plastic, $\boldsymbol{u}^P$, elastic, $\boldsymbol{u}$, and total, $\boldsymbol{u}^T$, displacement fields, and related distortions $\boldsymbol{\beta} = \nabla\boldsymbol{u}$, $\boldsymbol{\beta}^P = \nabla\boldsymbol{u}^P$, and $\boldsymbol{\beta}^T = \nabla\boldsymbol{u}^T$, so that $\boldsymbol{u}^T = \boldsymbol{u} + \boldsymbol{u}^P$ and $\boldsymbol{\beta}^T = \boldsymbol{\beta} + \boldsymbol{\beta}^P$. To see how stresses are generated, symmetric elastic, plastic, and total strain tensors are defined as symmetrized gradients of the displacement vector fields, respectively, $\boldsymbol{\varepsilon} = \nabla_s\boldsymbol{u}$, $\mathrm{d}\boldsymbol{\varepsilon}^P = \nabla_s\boldsymbol{u}^P$, and $\boldsymbol{\varepsilon}^T = \nabla_s\boldsymbol{u}^T$, so that the total strain tensor is $\boldsymbol{\varepsilon}^T = \boldsymbol{\varepsilon} + \boldsymbol{\varepsilon}^P$.

Dislocations and incompatibility law. In general, there is no plastic or elastic unique displacement fields in the welded macroscopic body, so neither $\boldsymbol{\beta} = \boldsymbol{\beta}^T - \boldsymbol{\beta}^P$ nor $\boldsymbol{\beta}^P$ can be expressed as gradients of the dis-placement fields. Instead, they can be defined as differential forms, $\boldsymbol{du} = \boldsymbol{\beta}\boldsymbol{dx}$ and $\boldsymbol{du}^P = \boldsymbol{\beta}^P\boldsymbol{dx}$, where $\boldsymbol{du}$ represents a change of a distance between points that were at a distance $\boldsymbol{dx}$ before the deformation. Distortions $\boldsymbol{\beta}$ and $\boldsymbol{\beta}^P$ are incompatible, if they are not compatible with the existence of a unique displacement fields and may not be expressed as gradients. The total distortion has to be compatible, as far as the body is not broken into pieces. This means that its rotation vanishes, $\nabla \times \boldsymbol{\beta}^T = \nabla \times \nabla\boldsymbol{u}^T = 0$. However, $\nabla \times \boldsymbol{\beta}^P = \boldsymbol{\alpha} \neq 0$, so for elastic distortion we have the first incompatibility law:

$$\nabla\times\boldsymbol{\beta} = -\boldsymbol{\alpha}\,,$$

with the dislocation density tensor, $\boldsymbol{\alpha}$, as a source of elastic distortion (Kröner 1981).

For strains, the incompatibility tensor is then defined as $\boldsymbol{\eta} = \nabla \times \boldsymbol{\varepsilon}^P \times \nabla$ (meaning that rotation is calculated column-wise then row-wise). It is equal to zero, if $\boldsymbol{\varepsilon}^P$ can be expressed as a symmetrized gradient of the plastic displacement field, $\boldsymbol{\varepsilon}^P = \nabla_s\boldsymbol{u}^P$. Since for the total strain tensor we have $\boldsymbol{\varepsilon}^T = \nabla_s\boldsymbol{u}^T$, the second incompatibility law is:

$$\nabla \times \boldsymbol{\varepsilon} \times \nabla = -\boldsymbol{\eta}\,,$$

with the dislocation incompatibility tensor, $\boldsymbol{\eta}$, as a source of elastic strains (Kröner 1981).

The second incompatibility law provides us with the geometric constraints on the elastic strain field, $\boldsymbol{\varepsilon}$, if sources $\boldsymbol{\eta} \neq 0$ are present. This local formula does not change when the elastic deformation described by any displacement field, $\boldsymbol{\lambda}$, is imposed. Any solution of the incompatibility law may be written as $\boldsymbol{\varepsilon} = \boldsymbol{\varepsilon}' + \nabla\boldsymbol{\lambda}$, where $\boldsymbol{\varepsilon}'$ is its particular solution. The compatible strains $\nabla\boldsymbol{\lambda}$, which can be produced by external forces, do not change the geometric constrains given by the incompatibility law. Using this invariance, the incompatibility law can be rewritten, in analogy to the Einstein's field equations, as $\boldsymbol{R} = \boldsymbol{S}$. Tensor field $\boldsymbol{R} = \Delta\boldsymbol{\varepsilon}$ represents space curvature and can be expressed as function of the metric tensor, whereas tensor field $\boldsymbol{S} = ½ (\boldsymbol{\eta} - \eta\hat{I})$, where η is the trace of the incompatibility tensor, represents sources of elastic strains and internal stresses in the medium.

The incompatibility tensor can be expressed as symmetrized rotation of the dislocation density tensor, $\boldsymbol{\eta} = (\nabla \times \boldsymbol{\alpha})_s$. For given internal stress sources $\boldsymbol{S}$, elastic strains can be calculated by using Green's function, as in the case of theory of gravitation.

Seismic moment tensor. The seismic moment tensor is one of the basic quantities characterizing the size and strength of a seismic source. Based on the scalar seismic moment, the so-called earthquake magnitude, m_W, is defined. The physical interpretation of the seismic moment is based on the concept of plastic deformations, i.e., inelastic, free of stress deformation of the medium within the seismic source volume (e.g. Udías et al. 2014; Madariaga 2015).

After the procedure described above, elastic strains are $\boldsymbol{\varepsilon} = \nabla_s \boldsymbol{u}^T - \boldsymbol{\varepsilon}^P$, where $\boldsymbol{\varepsilon}^P = 0$ outside the seismic source volume. The related stress field is, according to Hook's law:

$$\boldsymbol{\sigma} = \boldsymbol{C}\cdot\boldsymbol{\varepsilon} = \boldsymbol{C}\cdot\nabla\, \boldsymbol{u}^T - \boldsymbol{m} \,,$$

where the seismic moment density tensor, $\boldsymbol{m} = \boldsymbol{C}\cdot\boldsymbol{\varepsilon}^P$, is the excess stress, i.e., the difference between the stress due to displacements $\boldsymbol{u}^T$ and Hook's law, and the actual stresses in the medium. $\boldsymbol{C}$ is the elasticity or stiffness tensor.

The tensor field $\boldsymbol{m}(t, \boldsymbol{r}) = 0$ outside the source region. Its gradient determines the additional volumetric force to be included in the equations of motion for a continuous medium. Integrating over the source area, we get the tensor of the total seismic moment of the source:

$$\boldsymbol{M}(t) = \iiint d\boldsymbol{r}\, \boldsymbol{m}(t, \boldsymbol{r}) \,,$$

which can be interpreted as the internal stress generated in the medium by its inelastic deformation within the seismic source.

In the case of slip along a fault, displacement discontinuities are obtained by passing to the zero limit of the thickness, h, of the narrow zone of plastic deformation in such a way that the volume integral of deformations remains finite. We write the deformation tensor as a generalized function:

$$\lim_{h\to 0} \boldsymbol{\varepsilon}^P(t, \boldsymbol{r})\, h = [\Delta\boldsymbol{u}\, (t, \boldsymbol{r})\, \boldsymbol{n}]_s\, \delta(\boldsymbol{r} \in A) \,,$$

where $\Delta\boldsymbol{u}$ denotes slip along the plane A, and $\boldsymbol{n}$ is the unit vector normal to A.

The seismic moment density tensor is:

$$\boldsymbol{m} = \boldsymbol{C}\cdot\Delta\boldsymbol{u}\cdot\boldsymbol{n}\, \delta(\boldsymbol{r} \in A) \,,$$

and the total seismic moment is:

$$\boldsymbol{M}(t) = \iint dA\, \boldsymbol{C}\cdot\Delta\boldsymbol{u}(t, \boldsymbol{r})\cdot\boldsymbol{n} \,.$$

For isotropic medium $C_{ijkl} = \lambda\delta_{ij}\,\delta_{kl} + \mu(\delta\delta_{ik}\,\delta_{jl} + \delta_{il}\,\delta_{jk})$, so the seismic moment tensor can be written as:

$$\boldsymbol{M}(t) = 2\mu\overline{D}A[\boldsymbol{n}\cdot\boldsymbol{d}]_s \,,$$

where $M_O = \overline{D}\mu A$ is the scalar seismic moment, μ is shear modulus, $\overline{D}$ is mean slip, and $\boldsymbol{d}$ is the slip unit vector.

Other applications. Both discrete (Anderson et al. 2017) and continuum (Kröner 1981) theories of dislocations allow to model complex, heterogeneous seismic sources, including their static characteristics and long-range interactions, rupture dynamics, as well as aseismic processes leading to earthquake rupture. Their generalization to a more complex medium with asymmetric stresses, or non-symmetric elasticity tensor, rotational effects, and conjugated strain modes enabled Roman Teisseyre to develop his innovative approach towards earthquake source physics (e.g. Teisseyre and Teisseyre-Jeleńska 2014).

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A Short Story of My Search for Rotational Waves – from the Asymmetric Theory to DEM Simulations

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A b s t r a c t

In this short note, I present preliminary results of the simulation of rotational waves generation in a homogeneous amorphic material using the Discrete Element Method approach. It is demonstrated that in this type of material, the classical, transient rotational waves essentially do not exist, but the rotational energy is generated and accumulated near the free surfaces of fractures. This observation opens a question about the role of rotational effects in the total energy balance of the earthquake generation process.

1. INTRODUCTION

Rotational waves in solid media have been an intriguing issue for physicists for years; see, e.g. Kozak (2009). Within the classical linear theory of elasticity, such waves – transient propagation in time and space of rotational energy – do not exist. The reason is that the linear elasticity theory assumes that the considered perturbations (e.g. waves) are small in magnitude so the strain tensor is fully symmetric (Aki and Richards 1985) and a linear relation between stress and strain (Hook's law) can be assumed. In consequence, no rotational movement is supported by the theory. However, there exist more complex theories of elastic solids, like, for example, the micro-polar one (Nowacki 1986; Cosserat and Cosserat 1909) in which rotational waves can actually exist. This fact has been completely ignored in seismology for years, because in the course of its development the main effort had been directed towards an accurate description of mechanical (seismic) waves in so complex and heterogeneous medium as the Earth. In other words, the real problem in seismology was an accurate modeling of gross features of seismic waves and all "minor effects" have been put aside. Roman Teisseyre was probably the first person who raised the problem of rotational waves in a seismological context (Abreu et al. 2017). Through the years he has been continuing an effort of building a consistent theory of asymmetric continuum medium with the hope it can enrich seismology by a new tool to study the Earth and processes within it. At the beginning, his effort was treated mostly as an interesting, but only theoretical adventure because there was no observational evidence of such rotational seismic waves. Actually, there was no evidence because nobody was interested in

looking for such effects. Moreover, there was no available equipment that could measure such subtle waves. The situation started to change when observations of damages caused by earthquakes definitely proved the existence of rotational movements in epicentral areas (see, e.g. Cochard et al. 2006; Takeo 2006). From that time on, the interest in rotation waves in seismology has raised and rotational seismology has emerged.

When I came back to the Institute of Geophysics after 3 years spent with Prof. A. Tarantola at the Institute de Physique du Globe in Paris, I immediately encountered Roman Teisseyre and his "seismic rotational waves" issue. Being devoted to the inverse theory and its seismological application I have treated Teisseyre's attempt of building asymmetric theory predicting the rotational waves with some distance. However, many discussions and a minor help with numerical methods I gave him slowly raised my interest in this issue. Thus I have started to study his theory. Following his ideas of asymmetric continuum hidden in complex mathematical formulas and continuously changing notations was extremely difficult. What I have finally recognized, however, is that the existence of rotational waves, no matter how mathematically represented (e.g. by asymmetric stress tensor) requires an existence of "hidden degrees of freedom" in the medium. Fortunately, that time I have started numerical simulations using the Discrete Element Method – the method which by construction represents the medium by an ensemble of independent but interacting elements. The fact that these elements have not only the translational degree of freedom (the fact used in the classical theory of elasticity) but also rotational ones ("hidden degree of freedom") was an ideal starting point for analysing the rotational waves. I have quickly recognized this adventure of the DEM method and together with my former students (Natalia Foltyn, Alicja Kosmala, and Piotr Klejment) we have started some simulations of rotational waves. Unfortunately, it took much time to get some reasonable results so that I could not communicate them to Roman Teisseyre. I describe them here in a very short form to memorize how Teisseyre's devotion to this task inspired me to make a closer look at the rotational waves issue.

2. DEM SIMULATION OF ROTATIONAL WAVES

The discrete element method is a numerical tool originally designed to describe the behaviour of granular media (Cundall 1971, Potyondy and Cundall 2004). Its distinguishing feature is representing a medium in hand by a set of independent particles which can interact with each other. Since elements have a finite size, both translation and rotational movements are possible and time evolution is described by a direct application of the Newton (translational movement) and Euler (rotation) equation (Abe et al. 2014). Thus, the method offers a very elementary approach to dynamic simulations without any additional assumptions. The only information we need to provide is the rule of interactions between particles. For this reason, the method is very well suited for studying the rotational waves issue.

Using this method we have started from the simplest question of whether we can observe excitation of rotational degree of freedom in realistic conditions. To answer this question we have designed an experiment shown in Fig. 1. A thin plate built of bounded spherical particles was used as a model of amorphic solid material. At the beginning of simulation, one of the particles located near the centre of the plate starts to move right with a constant velocity. Its movement breaks some inter-particle bonds, creating a horizontal fracture and collision with other particles to transmit energy to the plate body. In such a configuration, "off-fault" secondary cracks are also created. Since the particle-particle interaction model allows for the existence of tangential forces in non-central collisions, which in our case dominate the energy transfer process, both translational and rotational energy is built up. In Fig. 2, a few snapshots of the process are shown with a separate presentation of translational (left column) and rotational (right column) energy. What is apparently visible is that the translational energy takes

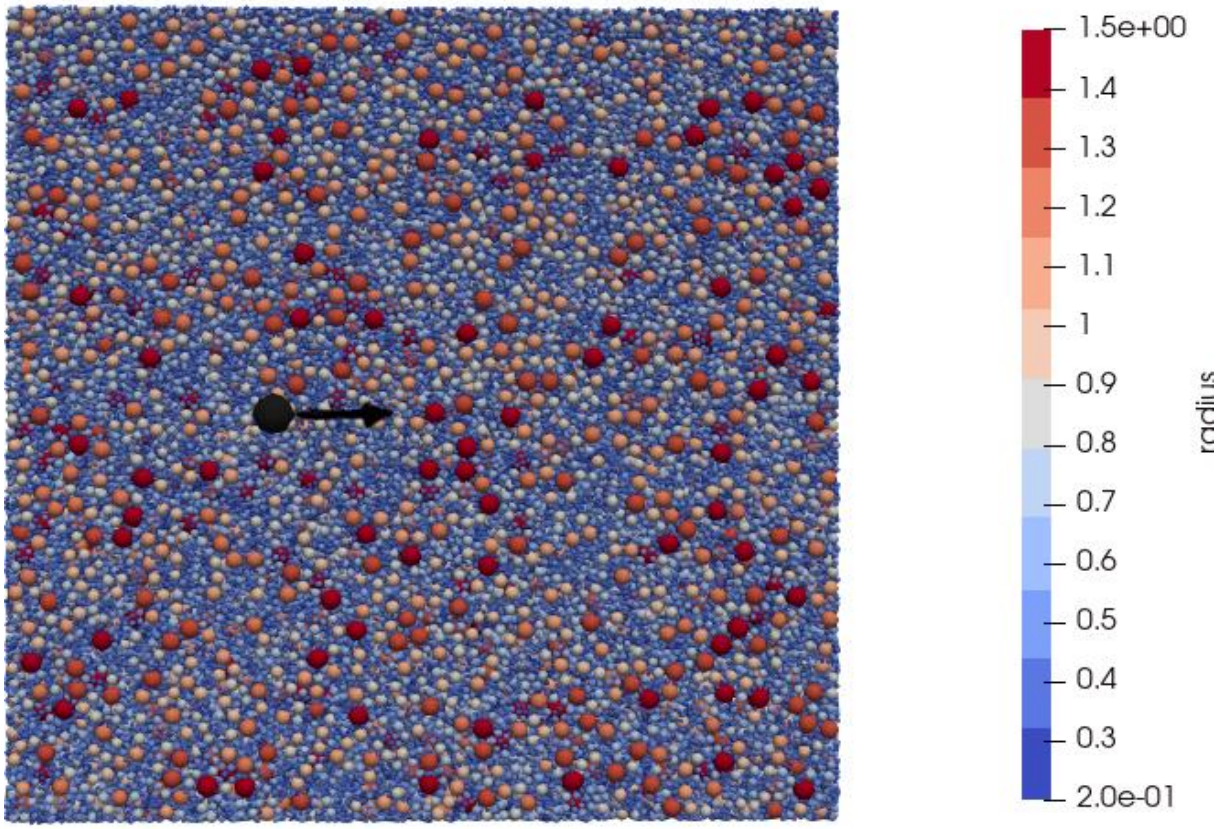

Fig. 1. Sketch of a numerical simulation setup designed for an analysis of rotational waves. The 5 cm × 5 cm × 6 mm "rock" sample has been built of spherical particles with radii in the range 0.2–1.2 mm. One of the particles (marked by black) starts to move right at the beginning of the simulation with a predefined velocity transferring energy to the plate.

the form of waves which propagate through the medium, as expected. The evolution of rotational energy seems to be different. It apparently concentrates around boundaries of both the main fracture as well as secondary, "wing" fractures and it essentially does not form the classical transient waves.

The conclusion of our simulations is by no means clear. We have essentially observed no running rotational waves. However, we have apparently observed a building of rotational energy in the plate. Although at first sight, this observation seems to be negative, it is really not the case. The observed spatial distribution of rotational energy can have an important impact on our understanding of the earthquake generation process. The point is that the whole classical analysis of earthquake mechanisms does not include the rotational energy in the energy budget of the earthquake (Cocco et al. 2023). However, Fig. 3 shows that such energy is comparable with the linear kinetic energy at the nucleation stage. Moreover, it concentrates around fracture surfaces where most of dynamical breaking process occur. The concentration of rotational energy around secondary "off-fault" fractures opens a question on its role in the creation of off-fault damages, well observed in real cases (Okubo et al. 2019). Currently, we have no answer to these questions. The dependence of the obtained results on the structure of the plate, including the size of the particles used and the way of energy excitation in the plate should also be analysed.

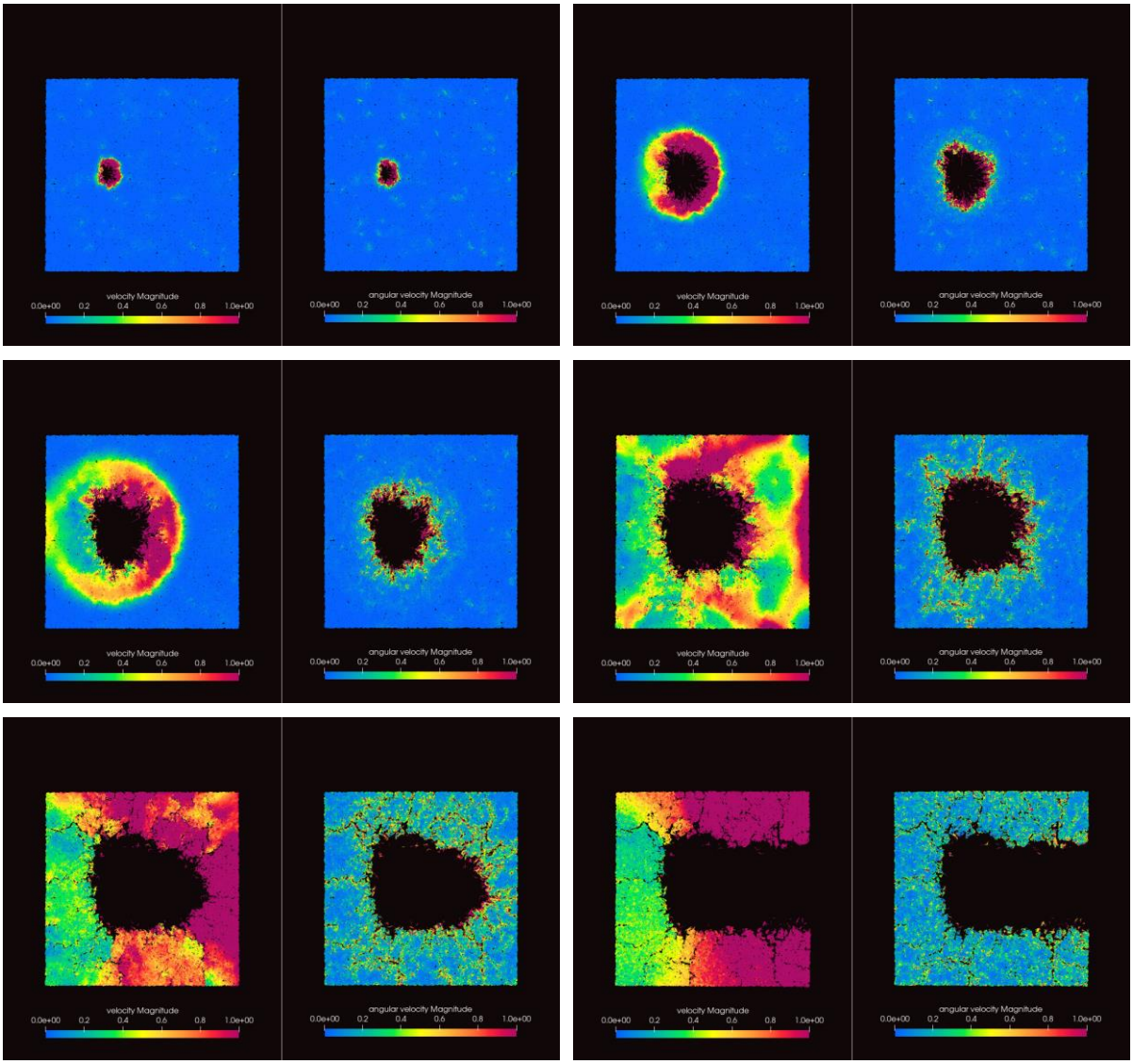

Fig. 2. Snapshots of linear and rotational velocity of particles building the sample. Each snapshot consists of two panels: left showing the linear velocity and right with rotational velocity, respectively. The snapshots correspond to simulation times 10 ms (left top), 30 ms (right top), 50 ms and 70 ms (middle row) up to 100 ms and 130 ms (lower row). Some inter-particle bonds are broken due to a movement of the "source" particle leading to creation of the main, horizontal crack and secondary, "wing" cracks. The formation of a classical (translational-type) acoustic wave is clearly visible at T = 30 ms and T = 50 ms. At later stages of the simulation, it undergoes a classical reflection from the boundaries of the sample (T = 100 ms). On the other hand, the rotational energy concentrates along the created free surfaces of cracks and does not form any visible transient wave-train.

3. CONCLUSION

The analysis presented here would have never been undertaken if not a curiosity of Roman Teisseyre for a deeper understanding of the surrounding world. Although his ambition of developing the theory of asymmetric continua has gone much further than seismology (we were even discussing gravitational theories) he has apparently opened a new branch of seismology – the rotational seismology. The questions which I have formulated at the beginning of this short

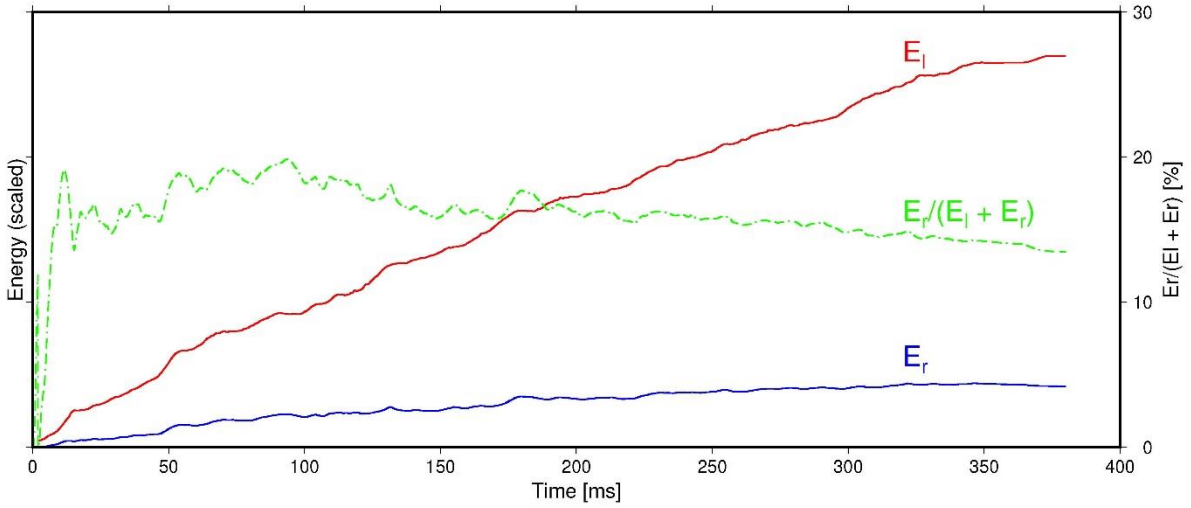

Fig. 3. Kinetic energies of linear (E_l – red line) and rotational (E_r – blue line) movements of particles. The ratio of rotational kinetic energy to the total kinetic energy ($E_T = E_l + E_r$) is shown in green. Let us note that during the initial phase of the rupture development, this ratio reaches a considerable value of 20% which means that in this stage the rotational effects are quite important.

essay and which follow from the simple numerical experiments are intriguing. I have no doubt that sooner or later they will find their proper analysis and satisfactory answers within the framework of the earthquake mechanics. I want to emphasize here that they are direct consequences of many discussions with Roman Teisseyre and my problems with a full understanding of the asymmetric continua theory which he was developing through many years of scientific activity.

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Roman Teisseyre (1929–2022) In Memoriam

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The death of Roman Teisseyre, an outstanding Polish geophysicist and scientist, means that those of us who knew him a little closer and longer should try to summarize his immense scientific achievements and bring his extraordinary figure closer to younger colleagues and alumni. This is not an easy task as his achievements are impressively large, enormous, and comprehensive.

Professor Roman Teisseyre was mainly a theoretician dealing with seismology and the physics of the Earth interior and a great part of his output concerns seismology, geodynamics, and thermodynamics of the processes of rock deformation and electromagnetic fields. A number of earlier works he devoted to one of the most difficult and controversial problems of seismology – earthquake prediction and, in particular, the generation of electromagnetic fields in the process of earthquake development and preparation.

Undertaking a (somewhat subjective) attempt to present his most important achievements I would count among them works in the field of:

- diffraction of electromagnetic field on a wedge (his PhD thesis – 1959),
- development of the foundations of the dislocation theory of earthquakes (together with Z. Droste) which takes into account interactions between fractures and explains the mechanism of large elastic energy release,
- development of dynamic relations and generalization of dislocation theory of earthquakes (habilitation treatise – 1961),
- introducing a generalized micromorphic description of the medium into seismology which allows, among other things, a broader explanation of the process of deformation and wave dispersion,
- development of the basis of the theory and interpretation of phenomena occurring before earthquakes, in particular, the development of the theory of stress build-up, induced changes of electric resistivity, and generation of electric fields in seismic areas,
- development of thermodynamical fundamentals of earthquake generation,
- the study and interpretation of telluric precursors of earthquakes in Italy, Greece, and China,

- development of a generalized model of a continuous medium with defects and with nucleation of deformations of the rotation and torsion type, and the theoretical demonstration and empirical confirmation of the existence of rotation waves propagating also in the Earth.

In his publications, the author sometimes used a conceptually advanced apparatus of theoretical physics, and, as a result, these works are not always easy to read and, additionally, understanding them requires adequate preparation.

A very important and significant contribution of Prof. Roman Teisseyre is the editing and co-authorship of a number of multi-volume and unique monographs on the physics and evolution of the Earth's interior, often published in English by reputable foreign (Academic Press, Elsevier) and domestic (PWN) publishing houses. These works try to synthesize the whole of the scientific problems of the physics of the Earth's interior and its evolution and constitute a major contribution to the world geophysics.

Despite the fact that Prof. Roman Teisseyre was mainly a theoretician, a number of his works and research had a clear practical and utilitarian character, which include:

- Initiation of modern mining observations; in particular, one should cite here the first work of this type implemented at the Miechowice coal mine in Bytom (together with S.J. Gibowicz, Z. Droste, J. Hordejuk, and M. Wernik) back in the 1960s. Roman Teisseyre's special achievements include the development of a model of the focus of the shock taking into account the non-shearing mechanism in the source. These works explained the mechanism of destruction taking into account the change of volume in the source, which was some surprise in seismology at that time, presented and discussed quite extensively at a conference in Cracow entitled "Problems of Geodynamics and Rock Bumps" in 1972, organized by the Mining Committee of the Polish Academy of Sciences;
- In 1962 he initiated innovative studies of glacier seismicity, which he continued in three geophysical expeditions to Spitsbergen (1974, 1978, 2000);
- In connection with the International Geophysical Year (1957–1958), Roman Teisseyre initially became secretary of the Committee of the Geophysical Year of the Polish Academy of Sciences, and then, in 1956–1959, an organizer and leader of the Polish geophysical expedition to Vietnam, where he organized two geophysical observatories – at the venues in Phu-Lien and Cha-Pa.

The result of such effective scientific activity was his rapid scientific advancement, as seven years after graduation (1952) he defended his PhD dissertation (1959), only two more years later (1961) he was habilitated and at the age of 38 he became an associate professor (1967) and in 1974 a full professor, at that time regarded as the most talented geophysicist in Poland. At the age of 40, he was appointed a correspondent member of the Polish Academy of Sciences, and in 1980 he became a full member of the Polish Academy of Sciences.

The achievements and merits of Prof. Teisseyre are associated not only with scientific work strictly defined, but also with many organizational functions he held in the scientific community. In 1953, he organized first the Department and then the Institute of Geophysics of the Polish Academy of Sciences in Warsaw, where until 1979 he headed the Department of Seismology, and since 1979 the Department of Dynamics of the Earth's Interior. For a number of terms, he served as a deputy director of the Institute, and in 1970–1972 also as a director of the Institute of Geophysics of the Polish Academy of Sciences (IG PAS), which soon became one of the leading scientific centers of the Polish Academy of Sciences in Poland. For many years he served as a chairman of the Scientific Council of the IG PAS. Also in the Polish Academy of Sciences itself, he held a number of responsible and managerial positions. He was deputy secretary of the Department of Math. Physics and Chemistry in 1973–1976 and Secretary of the Department of Earth and Mining Sciences in 1980–1993, while in 1981–1983 he was a member

of the Presidium of the Polish Academy of Sciences. He chaired the Committee on Geophysics of the Polish Academy of Sciences many times (for a number of terms), was also the Editor-in-Chief of *Acta Geophysica Polonica* and *Publications of the Institute of Geophysics, Polish Academy of Sciences*, inspiring and initiating editions of original scientific papers.

Roman Teisseyre's activities outside Poland are also rich and extensive, as he was repeatedly invited to and worked closely with the leading scientific centers of world geophysics. The following should be mentioned here:

- working as a UNESCO expert at the Institute of Seismology and Earthquake Engineering in Tokyo from 1965 to 1966,
- visiting professor at the Trieste-International School of Advanced Studies at the Center for Theoretical Physics in 1979–1980,
- University of Strasbourg (1984),
- University of Hokkaido-Sapporo, Institute of Seismology and Volcanology (1979).

He had scientific cooperation with Japan, USA, Italy, and Greece in the field of seismology and physics of the Earth's interior, which resulted in a number of joint works. For many years he was a member of the expert group of the UN Disarmament Committee in Geneva on the detection and identification of seismic phenomena (1972–1976), and was also a member of the European Advisory Committee in Strasbourg on earthquake prediction assessments. He also held numerous positions in international organizations:

- Vice President (1970–1976) and President (1976–1978) of the European Seismological Commission,
- member of the Executive Committee of the International Association of Seismology and Physics of the Earth's Interior (IASPEI),
- he was also a member of the editorial committees of *Garlands Beitraege, Bolletino di Geofisica Theoretica e Applicata* and *Pure and Applied Geophysics*.

He became a member of the Finnish Academy of Sciences and Literature as early as 1979, and a Doctor Honoris Causa of the AGH University of Science and Technology in Cracow in 2004. He was the initiator and also the organizer of numerous meetings, symposia, conferences, and scientific gatherings, among which I would like to highlight the Polish-Czech-Slovak symposia of mining, engineering, and environmental geophysics initiated in 1967 and continuing to this day.

A separate area to which he devoted considerable effort was the training of young scientists. He promoted as many as approx. 20 PhDs and served three terms as a member of the Central Qualification Commission for Academic Titles.

It should be emphasized that he came from a family of great merit in Earth sciences with a name well known to all Polish geophysicists and geologists. He was a man with patriotic traditions, since as a young boy he belonged to the secret scout organization "Szare Szeregi". He took part in the Warsaw Uprising and was awarded the Warsaw Uprising Cross in 1986, the Officer's Cross in 1961 and the Commander's Cross in 1969 of the Order of Polonia Restituta, as well as other Polish and foreign awards.

With such outstanding achievements and merits, his personality traits were particularly endearing: his openness and friendliness and especially kind attitude towards young people, his love of sports, for example, downhill skiing, and his extraordinary diligence. Although it is said that nobody is indispensable, the death of Professor Roman Teisseyre has created a gap among Polish geophysicists, which, I fear, will not be easily or quickly filled.

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Remembering Professor Roman Teisseyre

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I met Professor Roman Teisseyre in the spring of 1963 when I decided to apply for employment at the then Department of Geophysics, Polish Academy of Sciences. For the preceding two years I had been working as a research assistant to Professor Tadeusz Olczak in the Lithosphere Physics Department, one of the Departments of Geophysics, University of Warsaw. However, I did not see my future in theoretical research, since I was more interested in exploring the Earth through experimental investigations, while in the Seismology Department I was hired, such opportunities could not be expected. Professor Olczak accepted my resignation with true regret, but also with understanding, encouraging me to remain in regular contact with him, which I continued, with great benefits, until Professor's death.

Following the advice of Professor Olczak, I decided to apply for a job at the Department of Geophysics, Polish Academy of Sciences. I was hired by Professor Roman Teisseyre, the Deputy Head of the Department, who at that time was already after the doctorate and defended his habilitation. It was then that I met Roman Teisseyre, commonly referred to as RT, in person for the first time. Heavily grey-haired, with a youthful personality, eager to make jokes, he was quick to break the ice and establish lively contact with his interlocutor. Although I did not fit RT's personal preference, since as an eminent theoretical physicist he wanted to develop theoretical approach to study the earthquake mechanisms and be a mentor for young geophysicists in this field, I was hired as a senior research assistant. He initially tried to encourage me to change my interests by presenting relevant problems to be solved in theoretical seismology, but seeing the lack of enthusiasm on my part, he assigned me to the experimental lithosphere research laboratory. It was not an easy start. Geophysics at PAS, particularly seismology, suffered from a lack of highly qualified personnel. None of the seismology staff, apart from RT, was a PhD holder. So independence and maximum activity were required, while the foreign contacts were very limited. There was, by the standards of the time, a well-supplied library, and this was the basic source of knowledge for young seismologists. In such conditions, it was only possible to work effectively with the support and friendliness of management and colleagues, and such an atmosphere was created by RT.

One of the first tasks I was given was to organize, under the patronage of RT, nationwide geodynamic symposia in Jabłonna near Warsaw, in order to integrate various Earth researchers. These symposia, usually three days long, were very popular, provided opportunities for formal and informal discussions, and initiated joint research projects. The papers presented from 1975

onwards were published in *Publications of the Institute of Geophysics, PAS* (IG PAS 1976, 1980, 1984, 1985, 1991).

When, after several years of work and having completed my doctorate, I was already well acquainted with the research capabilities of the Department of Geophysics, PAS, and the cooperating institutions, first and foremost the Polish Geological Institute (PGI) and the Geophysical Exploration Company (presently the PBG Geophysical Exploration Ltd.) in Warsaw, and the AGH University of Science and Technology in Kraków, I presented to RT a more detailed program of deep lithosphere research by means of deep seismic soundings in Poland. I then had a key conversation with RT. He made it clear that he would not give me any professional help, but that I could always count on his goodwill and support. It was a very frank conversation, and, over the long years of my scientific activity, I have always felt RT's support. He was full of enthusiasm and encouragement for ambitious research projects, and willingness to promote young scientists. Whenever he saw a chance of success for a research project presented to him, he always offered help and, thanks to his wide international acquaintances, facilitated contacts with foreign geophysicists.

Our few joint publications were sort of summaries resulting from discussions between the results obtained from experimental studies and those expected from theoretical models of lithosphere structure (Guterch et al. 1968, 1980, 1981; Teisseyre et al. 2007).

RT was an enthusiast of polar research in the Arctic and Antarctic. Among other actions, he promoted a long-term, very fruitful cooperation between the Institute of Geophysics, PAS, and Professor Markvard A. Sellevoll from the University of Bergen in Norway in the study of the Earth's crust structure. The cooperation with Norwegian geophysicists still goes on.

Numerous scientific conferences we have attended together with RT have also provided an opportunity to discuss the state of geophysics and, in particular, seismology in Poland.

We were in close personal contact with Roman and his wife Elżbieta. It became customary that visits of foreign guests to the Institute were occasions for social gatherings in private homes, most often at the home of Roman and Elżbieta Teisseyre, Kacper Rafał Rybicki and his wife Alina Wołowska, or at the home of myself and my wife Barbara. Ms. Elżbieta Teisseyre and Ms. Alina Wołowska were masters at preparing simple yet exquisite dishes, which, especially in the 1990s in Poland, during the coarse period of the communist regime, with a notorious shortage of everything and particularly acute shortage of foodstuffs, was quite an art and an undoubted attraction. Additional attractions of our social gatherings were trips, usually in summer, to the home of Kacper Rybicki and Alina Wołowska on the Pilica River.

I have not done any common research with RT, but as long as he could formally help, being the Director or Vice Director of the Institute, he always did, never refusing. Hence my great gratitude to the Professor. This is how my collaboration with Professor Roman Teisseyre went over the years. It was my side path by the road of Roman Teisseyre, to paraphrase Polish poet Kazimiera Iłłakowiczówna (1989).

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Wonderful and Yet Strange is This World – My Tribute to Professor Roman Teisseyre

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On 21 November 2022, Monday, a few minutes after 10 am, during the session of the 6th Meeting of International Working Group on Rotational Seismology (IWGoRS), I received a text message with the sad news from Krzysztof Teisseyre that his dad Roman had just passed away. We were at the Insititut de Physique du Globe in Paris, in a straight line about 100 m from the Marie Curie-Sklodowska's Laboratory, room kept as if she had just left for a while. It is significant that at this moment in the room Dr. Anjali C. Dhuba (post-doctoral fellowship at Universität Hamburg) was presenting a paper: "A Rotational Low Noise Model Reduced Micropolar Theory: an alternative to model the Earth Medium and simulate earthquake ground motions?". Thus, Roman's ideas are not going away, they are still alive....

I have known Prof. Roman Teisseyre for more than 20 years. At the beginning of this century, based on a conversation with Prof. Katarzyna Chałasińska-Macukow, Her Magnificence Rector of the University of Warsaw, during the SPIE congress in San Diego, USA, I got a contact to Prof. Roman Teisseyre for consultation regarding the possible occurrence of rotation in the ground. We observed such effects with the help of a uniaxial fiber-optic gyroscope installed at the Military University of Technology (MUT) after a streetcar passed nearby. Interestingly, the MUT located in Warsaw on Gen. Sylwester Kaliski Street is the closest scientific unit to the Institute of Geophysics, PAS (IG PAS) located on Księcia Janusza Street, and contacts are made in the US… Then I met Prof. Teisseyre for the first time, at his place in the Institute, and he immediately suggested to me – then a postdoctoral fellow – that we call each other by our first names. Based on this meeting, at the end of 2001, we made a joint check of the TAPS (Twin Antiparallel Pendulum Seismometers) system of IG PAS, based on FOG – a fiber-optic gyroscope adapted as FORS-1 (Fiber-Optic Rotational Seismometer), archival photos of which are in Fig. 1.

I think it is important to emphasize that Roman was an outstanding scientist, a physicist, but a theoretician. He was fully aware of this and said "that he is such an incorrigible theoretician that when he eats a soft-boiled egg for breakfast, I get all splattered with it". I, on the other hand, consider myself to be a technical physicist, which often led to some consternation, because Roman knew how something should work, while I knew how something works – and that's a crazy difference. Hence, in the early days of our acquaintance when I started working

Fig. 1. November 2001: IG PAS joint launch of the two systems, TAPS and FORS-1. Left photo – Prof. Teisseyre and Dr. Eng. Jaroszewicz point fingers at their own children, TAPS and FORS-1. Right photo – Prof. Teisseyre with employees of IG PAS and MUT analyse recordings from both systems.

on a fibre-optic rotating seismometer, it was difficult for me to get information from Roman about the required technical parameters of this system – our conversation: "Roman – what sensitivity? Leszek – as high as possible, Roman – what detection bandwidth? Leszek – you know it should be adequate to measure everything, Roman – and what is the maximum amplitude of measured angular velocities? Leszek – obviously very large. Roman – and on top of that the arrangement is probably supposed to be small, portable, operating autonomously, Leszek after all that's obvious."

I recall two important facts from the first period of our collaboration. Firstly, the theoretical and experimental work related to the analysis of the operation of the TAPS system and the validation of its indications by means of FORS-1, a system being a mobile adaptation of the model of the FOG created within the framework of my doctoral thesis of 1988 (Jaroszewicz et al. 2003 b; Solarz et al. 2004). However, more important is the second issue – Roman's inspiration to give him a rotational seismograph in line with his theoretical inspirations: with maximum sensitivity, wide amplitude of measured rotations, extreme bandwidth, etc., which we managed to define for the field of rotational seismology as late as in 2016 (Jaroszewicz et al. 2016b). The FORS-1 system, with a sensitivity of the order of 10^{-6} rad/s, proved to be an undersensitive instrument, as indicated by its use together with a set of two TAPSs in the existing Seismological Observatory in Ojców (Jaroszewicz and Krajewski 2002; Jaroszewicz et al. 2003a) as well as in Książ (Jaroszewicz et al. 2005b) at the beginning of the 21st century. Nonetheless, field studies from the late 2002 and early 2003 (Jaroszewicz and Krajewski 2002; Jaroszewicz et al. 2003a) probably represent some of the first works in the world demonstrating the feasibility of building a fibre-optic rotating seismograph based on the use of the Sagnac effect.

It was at Roman's inspiration that we undertook the construction of a new fibre-optic rotational seismometer – FORS-II (with a 0.63 m diameter sensing loop, containing 11 130 m of SMF fibre, which provided a sensitivity of $4 \cdot 10^{-8}$ rad/s). The essence of its application (together with a two-TAPSs) in the Seismological Observatory in Ojców was the recording at the end of 2004 of the occurrence of a delay of the rotational component in relation to classical *P* and *S* seismic waves in the near field for events generated in the Lubin or Silesia regions (Jaroszewicz et al. 2005a; 2006b). I consider this to be one of the most important statements that, through Roman's theoretical work (Teisseyre and Majewski 2001; Teisseyre 2004), lead to the occurrence of rotational seismic waves according to his ideas. Unfortunately, a single measurement system was insufficient for further validation of the results, especially as we did not have a re-

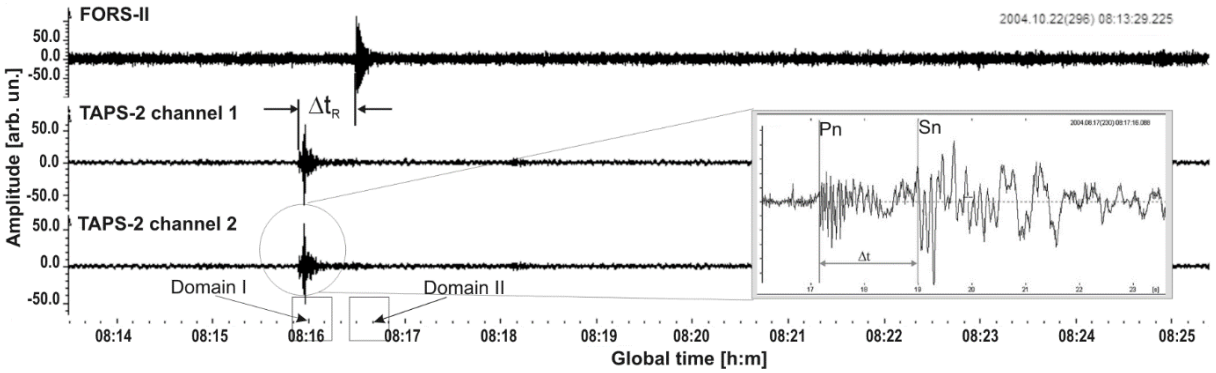

Fig. 2. Seismogram of the seismic events recorded on 22 October 2004 at 8 h 13 min by FORS-II and Second TAPS with two selected domains: Domain I where two channels of TAPS-2 detected classical seismic wave, and Domain II delayed about Δt_R where FORS-II detected rotational component. The insets show the method of time delay identification between *S*-waves (*Sn* line) and *P*-waves (*Pn* line) (from Jaroszewicz et al. 2006b).

liable data recording system at the time, and the electronic part was based on the use of laboratory equipment difficult to stay in the humid environment of the seismological laboratory in Ojców. Nonetheless, thanks to the cooperation with Roman, we came up with our concept of using a fibre-optic rotational seismometer in significant book positions published by him as co-editor in the Springer Publishing House in 2006 (Jaroszewicz et al. 2006a; Jaroszewicz and Wiszniowski 2008) (see Fig. 2).

The next one of our AFORS-1 (Autonomous Fiber-Optic Rotational Seismograph) measuring instruments is a fully mobile single-axis rotational seismometer that measures rotational disturbances autonomously. It was installed at the Seismological Observatory in Książ under Roman's supervision in July 2010, as evidenced by the archive photos below (Fig. 3). This system, with a sensitivity of 10^{-9} rad/s, was continuously operated for seven years, recording torsion-type disturbances from earthquakes in the far field as well as in the near field (Jaroszewicz et al. 2011, 2012; Kurzych et al. 2014), until it was found to be faulty in July 2017 – the fibre-optic cables had been bitten by rats (see an inner window in the photo below). During this

Fig. 3. July 2010: Prof. Jaroszewicz, Prof. Teisseyre, and an employee of the IG PAS Seismological Observatory in Książ (left photo) during the installation of the AFORS-1 in the measurement chamber at the Seismological Observatory in Książ (right photo) together with the view in the lower right window of the AFORS-1 destroyed by rats in July 2017.

period, it was possible to confirm that torsion-type disturbances are recorded synchronously by the AFORS system as well as TAPSs, i.e., that they are not correlated with *P* or *S*-waves (Jaroszewicz et al. 2012).

Towards the end of the first decade of the 21st century, issues of rotation took on a new face related to their vital importance for construction and, more specifically, the effect of the rotational component on irregular and complex structures. In a way, they were stimulated by Dr. William H.K. (Willie) Lee from the US Geological Survey, who unfortunately also passed away from us in November 2022; he selected from all over the world various persons dealing with the subject of seismic rotation (including Prof. Teisseyre, Prof. Majewski, and Prof. Zembaty from Poland) and invited them to Menlo Park, California. This meeting was, in fact, the first seminar of the newly formed International Working Group on Rotational Seismology (IWGoRS, https://www.rotational-seismology.org), which is still active today. The May 2009 special issue of the *Bull. Seismol. Soc. Am.* [vol. 99, no. 2B], which includes two papers by Roman, is the foundation of the research area for rotational seismology defined there as, quote: "an emerging area of analysis of all aspects of rotational ground motions forced by earthquakes, explosions, and ambient vibrations" (Lee et al. 2009). Roman was a recognised member of the IWGoRS, while the group itself is extremely active as evidenced, for example, by joint tests of various types of rotational seismometers, one of which took place in Germany near Munich in 2019, gathering more than 40 instruments in one place (Kurzych et al. 2020; Bernauer et al. 2021).

Hence, rotational seismology, in addition to research strictly related to seismology, also includes the so-called engineering applications referred to by Prof. Zembaty as seismic engineering of irregular structures. In this field, regular conferences have been held for years within the framework of the European Workshop on the Irregular and Complex Structures (EWICS), which have resulted, among other things, in monographs published by prominent publishing houses such as Springer. Constructed, undoubtedly under Roman's inspiration, our fibre-optic rotating seismometers AFORS, FOS4, FOS5 are used in this research – see e.g. (Jaroszewicz et al. 2013, 2016a; Jaroszewicz and Kurzych 2018).

In 2011, the 6th EWIC Conference was held in Haifa, Israel. Roman, at 82 years of age at the time, took an extremely active part in the event, as documented by the photos below. As a reminiscence, I will cite here two amusing incidents that perfectly illustrate him as a person. I was flying to Haifa with my wife via Vienna, at the time there was no direct connection from Poland, and because of my size, I always chose the seat next to the aisle. Suddenly, someone grabs my right arm, I raise my eyes and see a beaming Roman standing over me, I am completely surprised. So, I ask what he is doing here and Roman in his style says: "Leszek how good to see you, what are you doing here?". I say: "My wife Krysia and I are going to Haifa for the 6-EWIC Conference", and Roman says: "That's great, because, you know, me and Bogna (Roman's wife) are going to this conference too, but you know, I don't know anything about it, I don't know what days it is, where the sessions are going to take place and in general I was very worried about it, but you're going to be here, so I'm calm". All Roman, flying all over Europe, without a plan, somehow it will happen – pure theorist. After the conference, we hired a car to visit the cradle of Christianity, especially as Roman and I as well as our wives were in Israel for the first time. Roman was particularly excited about visiting the Dead Sea and being able to swim in it. Bathing in the Dead Sea is exciting because of its salinity, which causes the swimmer to float on the surface, but one must be particularly careful not to choke on this brine or get their eyes wet. Well, I am swimming, floating on the surface of the Dead Sea and I see Roman who carefully steps onto the pier and then runs and JUMPS HEADFIRST into the water!!! There were dozens of people in the water and on the shore, all frozen. The moment Roman emerged from the water the closest people rushed to help him, bringing him ashore and then

sacrificing their own fresh water, invaluable due to the 40+ degree heat, to wash his eyes and face. When Roman has cooled down a little, I ask him: "Romek what have you done, after all we talked about being VERY careful in the bath and under no circumstances dipping your head in the sea". To which Romek replied: "Leszek, I know it, but all my life I've dreamt of bathing in the Dead Sea so much, so that when I saw it, I just went mad", it is the whole Romek. Some photos of our trip to Israel are in Figs. 4 and 5.

As I mentioned in the introduction, I am a technical physicist not a theoretical one, hence the intricacies of the tensor notation used by Roman are not achievable to me. However, when analysing his works, I believe that in many of them he was guided by scientific intuition, a trait of the few, often unsupported by a proper argument, which he was repeatedly reproached for. Perhaps this was influenced by his initial scientific path in the 1950s in Leopold Infeld's theoretical physics group. I regard this scientific intuition as extremely important: when in the 1970s he postulated the existence of at least a rotational component in seismic waves, let alone the existence of seismic rotational waves, nobody was taking it seriously. Today, however, after half a century, the existence of rotation even in homogeneous media is widely recognised and studied. Admittedly, they require a new class of measuring instruments, but this provides a field of scientific work for others, including myself, which I am very pleased about.

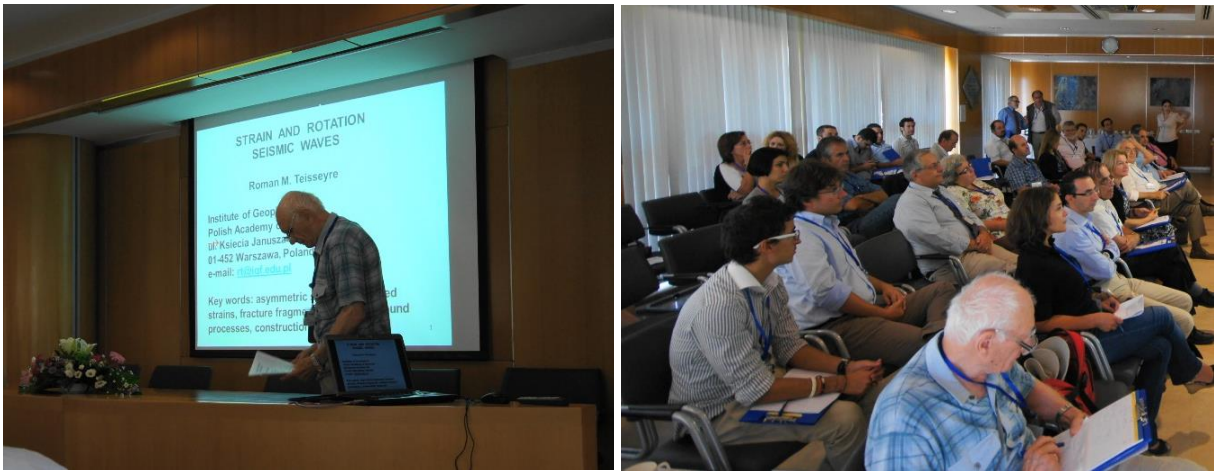

Fig. 4. September 2011: Prof. R. Teisseyre at a plenary address and session during the 6th EWICS, Haifa, Israel.

Fig. 5. September 2011: during the 6-EWICS tour in Israel. Left photo: Prof. R. Teisseyre with my wife in front of the board indicating zero level on the way to the Dead Sea located in a 300 m depression. Right photo: Roman with his wife Bogna in Nazareth.

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Memorable Interactions with Professor Roman Teisseyre

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I first heard of Prof. Roman Teisseyre in the early 1970s, shortly after I began my research in seismology as a graduate student at the University of Tokyo. In the early 1970s, it had just been mathematically proven that earthquake rupture could be represented by a double couple using the elastic theory of dislocations, and there was a flurry of research attempting to understand various aspects of earthquake rupture using the elasticity theory of dislocations. It was one such study that brought me to know the name of Prof. Teisseyre. Namely, a paper about the mechanism of earthquake swarms based on the elasticity theory of dislocations, co-authored by him and Keichi Kasahara, who was then a professor at Earthquake Research Institute (ERI) of the University of Tokyo. I remember being inspired by this paper, but it was nearly 30 years later that I could write my own paper on the mechanism of earthquake swarms. At the time of writing the above paper, Prof. Teisseyre was teaching at the then International Institute of Seismology and Earthquake Engineering (IISEE) in Tokyo (now relocated to Tsukuba City) as a United Nations educational expert.

However, it is not clear how we came to know each other. Since he had maintained strong ties with Japan after his stay at IISEE, it is likely that we met in Japan. Anyway, we had some interesting academic discussions at ERI. Those discussions resulted in joint papers. Research exchanges with him continued, and his young colleagues (Profs. Z. Czechowski and P. Senatorski) also visited ERI and stayed there for a while. Although I am a seismologist myself, the collaboration with the group of Prof. Teisseyre allowed me to learn different perspectives on deformation phenomena. I have also visited the Institute of Geophysics PAS twice, the second time with my wife, and the kindness of Prof. Teisseyre and other people at the Institute made our visits memorable. All in short, thanks to Prof. Teisseyre, I was able to have a broad exchange with people at the Institute of Geophysics PAS. This was not only an academic exchange, but I also learned a lot about the history and culture of Poland. I would like to express my deepest gratitude to Prof. Teisseyre. I could see him for the first time in many years during the 2015 IUGG meeting in Prague and renew old friendships. Unfortunately, that was the last time I saw him.

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To the Obituary of Professor Roman Teisseyre

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I am shocked and full of regret to hear the news of Professor Roman Teisseyre's passing. In fact, I came to know it at the request of this memorial letter. The sight of the tall, slender teacher, nodding his head and speaking with enthusiasm, reminds me of the year I researched with him as if it were only yesterday. When I recall his kindness behind his glasses, I am filled with gratitude.

I met Professor Roman Teisseyre 26 years ago, as a Japan Society for the Promotion of Science (JSPS) researcher dispatched to specific countries. I studied and wrote papers at the Institute of Geophysics, Polish Academy of Sciences (IG PAS), for one year and received guidance from him. When I read his paper for the first time in Japan, I could feel the scientific sense of theoretical physicist Leopold Infeld in the background of his research. So, I asked the Professor if he would accept me as a JSPS Research Fellow for a Specific Country, then he rapidly and kindly accepted my request to study in Poland. And then, from April 1997, I began to do research under the guidance of the Professor for one year. I think the reason why I could receive his acceptance even though I am a geologist is the fact that his grandfather, Wawrzyniec Karol de Teisseyre, was a world-famous Polish geologist.

In research, I was able to publish 10 co-authored papers and a co-edited book (R. Teisseyre, H. Nagahama, and E. Majewski (eds.), *Physics of Asymmetric Continuum: Extreme and Fracture Processes*, Springer-Verlag) with him. One of the most memorable research results is: H. Nagahama and R. Teisseyre (2008) *Continuum Theory of Defects: Advanced Approaches*. The above is a summary of the discussions with the Professor over coffee. Now I feel once again that this publication combines relativistic physics, continuous dislocation distribution theory, or continuum mechanics with internal rotation and structure of Professor Roman Teisseyre. One of our coffee meetings, this time in a broader company, is shown in Fig. 1.

Moreover, he took care of my family. Looking back, we visited Chopin's birthplace, the laboratory of Professor Roman Ingarden (theoretical physicist) at the Nicolaus Copernicus University in Toruń, the Royal Palace (Zamek) in the old city of Warsaw, and also, in Japan, we visited the Zao volcano and Matsushima in Miyagi Prefecture. I and my wife still have many fond memories of exploring the bay and Zuiganji Temple in Matsushima, Miyagi Prefecture, with the Teisseyres. I am still so grateful to the Professor, his wife, and the researchers of the IG PAS for taking such good care of my three-year-old son (at that time), Motoaki. For my son,

Fig. 1. Mr. and Mrs. Roman Teisseyre, Mr. and Mrs. Krzysztof Teisseyre and me.

as well as for my wife and me, the experience of staying in Poland and interacting with researchers will remain in his heart for the rest of his life.

Upon hearing the news of the passing of Professor Roman Teisseyre, I would like to express my heartfelt gratitude for the kind guidance that I received from him and my heartfelt prayers for the repose of his soul.

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Remembering Professor Roman Teisseyre

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In the late 1980-ties, while staying on a postdoc at Milan Polytechnique with Prof. Alberto Castellani and doing research on seismic rotations, I was not aware that this subject already had a long geophysical track of investigations in Poland. After a few publications that appeared during the early 1990s, I changed my subject of research but soon was informed that Prof. Teisseyre read some of my papers and subsequently invited me to participate in a monographic collection of papers prepared for Springer (Teisseyre et al. 2006). On the other hand, I knew the name of Roman Teisseyre for many years since, as a youngster, I used to buy books from the popular Polish series "Omega". Among these books, the one titled "Interior of the Earth Shapes its Surface" (Czechowski and Teisseyre 1981) was on my shelf.

Soon after the above-mentioned Springer monograph appeared, a research seminar started in 2007, with the aim of energizing wider investigations of seismic rotations, which had not been popular among geophysicists or engineers. The Seminar was organized by Willy Lee from the US Geological Survey, who selected the participants based on their activity in rotational seismology and invited them to Menlo Park, California (Figs. 1 and 2).

This was the moment when I met Professor Roman Teisseyre personally. From the very beginning, at the SFO airport in San Francisco, he made a very nice impression on me by giving a handshake and saying: "My name is Romek". I did not expect such a straightforward approach from such a scientific VIP to a stranger. Interestingly, the thought-provoking evening discussions with Professor presented me his outstanding personality of a world-class geophysicist and a warm, nice person in direct contact. Later, the 2007 workshop in Menlo Park appeared to be the first seminar of a newly born "rotational" working group IWGoRS (https://www.rotational-seismology.org/), which became very active from that moment.

Part of the reason for initiating this research area and gathering selected researchers from all over the world derived from an apparent crisis of the US gravitational wave detection program known as the LIGO project. After 10 years of unsuccessful search for the gravitational waves, it appeared that too low an accuracy of the first recordings of the large LIGO installations in Hanford and Livingston derived from the underestimation of the rotational effects. During the last day of the Seminar, we had a "brain storm" discussion with the LIGO project physicists and engineers led by Brian Lantz and Riccardo DeSalvo. Two years after the Menlo Park seminar, a special issue of *BSSA* appeared (Lee et al. 2009) with two papers devoted to the

Fig. 1. Willy Lee opens the first Seminar on rotational seismology and engineering in Menlo Park, California, in 2007.

Fig. 2. Prof. Roman Teisseyre (on the right) with Dr. Marek Górski in Menlo Park, California, in 2007.

Fig. 3. Prof. Roman Teisseyre with his wife Bogna and Prof. Avigdor Rutenberg during the 6th EWICS Conference held in Haifa, Israel, in 2011.

problems of the LIGO project and its "rotational ground motion" correction. Ten years later, the "Advanced LIGO" project led to a breakthrough in the gravitational wave detection and to a Nobel prize.

Later on, I met Prof. Roman Teisseyre again, this time in Haifa, Israel, during the 6th EWICS Conference I co-organized, devoted to the seismic engineering of irregular structures (Fig. 3). The EWICS conferences also deal, indirectly, with the rotational seismic effects, and are organized since 1996 in various countries, including Israel (Lavan and De Stefano 2013).

The Professor's indefatigable life energy prompted him to come to Israel despite his serious health problems and to actively participate both in the conference lectures as well as in other activities that accompanied the conference. On October 17–18, 2014, the 7th EWICS Conference was held in Opole, Poland. Professor Roman Teisseyre contributed a chapter (Teisseyre 2016) to the post-conference Springer monograph, though, due to his age and health issues, he could not take part in that event.

Looking from the field of seismic engineering, one should appreciate the research incisiveness of Professor Roman Teisseyre, who, as early as in the 1970s, considered the issues worth investigation, which only 4 decades later started to be appreciated by geophysicists and seismic engineers.

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Professor Roman Teisseyre in the Lower Silesian Geophysical Observatory

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The Lower Silesian Geophysical Observatory, situated at the Książ Castle (Fig. 1), was established in 1970. Its location was chosen by Professor Roman Teisseyre, who became acquainted with this place – the Castle and the undergrounds – much earlier: in August 1946.

Fig. 1. The Książ Castle.

In the late 1960s, while being the Scientific Director of the Institute of Geophysics, he took the decision to locate the Geophysical Observatory there, upon the seismic reconnaissance of the geological background of the Castle site.

The Observatory performs the recording and interpretation of earthquakes registered in the Polish Seismological Network – PLSN – in Poland and Spitsbergen. This applies to shocks recorded from a distance of up to 300 km from a given seismic station. The data is processed on the basis of digital records. The results are transmitted to the Seismology Department of the Institute of Geophysics in Warsaw, to European seismological centers, and the USA. Monthly bulletins are also posted on the website of the Institute of Geophysics in Warsaw.

The above text comes from the information about the Institute of Geophysics in the basement of Książ Castle. Photo of the basement is in Fig. 2.

And here are some more details of how it happened. Namely, Professor Roman Teisseyre as a teenager came with his parents to Jelenia Góra in Lower Silesia in 1946. There he learned that near Wałbrzych there was a beautiful castle worth visiting. He and his friends were able to visit the castle in August 1946, since it had been open to the public after the Red Army left it. Touring through the estate, he learned about the vaults carved into the rock, 49 m below the courtyard. He kept the impressions of that tour in his memory while being a scientist.

The Lower Silesia region, after the demolition of the Geophysical Observatory in Wrocław during World War II, had no place in which the movements of the Earth's crust could be monitored. A new station was needed to complement the Polish Seismological Network in this area. And then Professor Roman Teiseyre brought to mind the object in Książ. Geological and seismological verification was carried out by the Institute's seismologist Andrzej Zawada, a man who is better known for his successes in the Himalayas climbing. Positive results led to the decision to build the Observatory in Książ. After obtaining all official permits, the Lower Silesian Geophysical Observatory in Książ was established in 1970 and is still successfully operating.

Fig. 2. Basement in the Książ Castle.

Summer 1970. A newly built facility had guest rooms. During the summer vacation, Professor Roman Teisseyre came to Książ with his sons Krzysztof and Mikołaj and their cousin Grzegorz. And then I had the opportunity to meet Professor in person, not realizing that as a 14-year-old boy I was talking to a world-renowned scientist!

In Książ, there was no restaurant or bar where we could eat dinner. We ate all meals together in our apartment where my mother still lives today. We spent our summer days and evenings together with guests from Warsaw; I still remember how the Professor talked about his scientific travels, especially those to Japan.

We explored the surroundings of Książ Castle and Wałbrzych. The ruins of Old Książ, the Książ Gorge, the Palm House in Lubiechów, and Chełmiec Mountain were our daily trips. The castle was not open to visitors, but my parents had a key and we could stay there without restrictions. There was an active fireplace in the Powder Tower on the castle terraces, at which we also spent several evenings...

Thirty-nine years after his first visit to Książ, Professor visited us with his grandchildren Stanisław and Katarzyna. Pictured on the left is Jozef Weiss, the observatory head, and on the right is Professor Roman Teisseyre (Fig. 3).

Fig. 3. Professor Teisseyre with his grandchildren visits the Observatory in 2009.

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Roman Teisseyre's Involvement in Field Research

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Professor Roman Teisseyre was mainly a theoretician but often wanted to verify or supplement the results of his research on the basis of measurements done in permanent geophysical observatories and/or specifically designed field projects in various field conditions. One of such projects realized in the last twenty years concerned the study of seismic waves in glaciers. The other was a search for records of rotation seismic waves based on continuous data from various observatories and targeted measurements in these observatories. The results of theoretical and experimental investigations have been described in many publications listed in the bibliography at the end of the present book.

We often participated in organizing and were members of Roman's field campaigns. It was a real pleasure to work with him. He was a cheerful, cordial, colorful, cooperative, and non-confrontational personality, and thus an excellent companion in such expeditions, where a good team atmosphere is very important. He had an excellent sense of humor and willingly participated in friendly gatherings, preferably with wine. He liked long scientific discussions, to the great benefit of the interlocutors. Roman was also an enthusiastic tourist, which is why we began this text with a photo of Roman and his wife after arriving in the Austrian Alps to make seismological measurements (Fig. 1).

The main aim of the expedition to the Austrian Alps was the study of icequakes. Roman was a pioneer in this kind of research, using seismometers deployed directly on ice. He started the measurements on the Hans Glacier in Spitsbergen as early as 1962, and then, after years, took the decision to continue them on the Pasterze Glacier, Austria (presently, because of global warming, this glacier is gradually decreasing in size). The next two photos (Figs. 2 and 3) illustrate how the specially designed seismometers were installed on the glacier's surface.

The other project was the search for records of rotation seismic waves: Roman carried out systematic investigations based on continuous seismic data in various observatories, mainly in Ojców, Poland, and L'Aquila, Italy. The Observatory in L'Aquila, where research has been done in cooperation with Italian scientists from the *Instituto Nationale di Geofisica e Vulcanologia*, is located in the deep basement of the Renaissance Castle (Fig. 4). Special seismometers to record rotation seismic waves were constructed at the Institute of Geophysics PAS and deployed in this Observatory (Fig. 5).

Fig. 1. Austrian Alps: Roman and his wife Elżbieta arrived at the mountains.

Fig. 2. Austrian Alps: It’s not easy to install seismometers on a glacier.

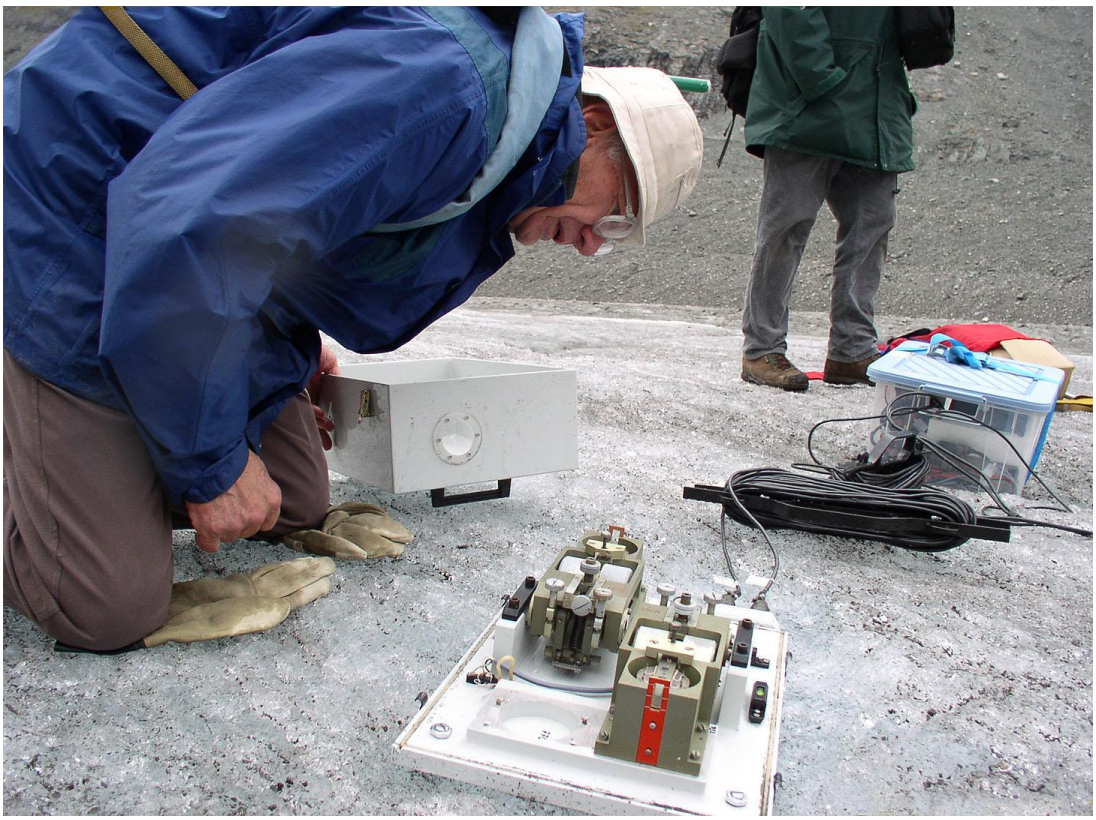

Fig. 3. Austrian Alps: Will it work?

Fig. 4. L'Aquila, Italy: Seismological Observatory is located in the deep basement of this castle.

Fig. 5. L'Aquila: Roman and Jerzy Suchcicki with the seismometers installed in the deep basement of the castle.

The last photo (Fig. 6) illustrates the the seismological team after some field measurements.

Fig. 6. The seismological team after one of the laborious days (from the left: J. Reda, W. Jóźwiak, T. Ernst, and very happy Roman Teisseyre)

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About Roman Teisseyre

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I remember Roman as a highly kind boss to whom I owe a lot, who always helped me when needed. And there were a lot of such situations when I needed help.

My first meeting with Roman was not encouraging. It was in Moscow during the IASPEI conference in 1971. I have half a year left to finish my studies at the Faculty of Physics at Lomonosov University in Moscow and return to Poland. My Moscow boss, Professor J.F. Savarenskii, decided to introduce me to Roman and thus secure a job at the Institute of Geophysics of the Polish Academy of Sciences (IG PAS) in Warsaw. Indeed, such a meeting took place, and Prof. Savarenskii recommended me as an excellent material for a scientist. But, from Roman's reaction, it was not difficult to deduce what he thought about my employment at his Institute. Such a prospect was not thrilled. Years later, when we became friends, Roman told me why my stay at IG PAS was inappropriate. He feared that an extended stay in the Soviet Union and systematic propaganda made me a communist. It should be remembered that at that time, in the seventies, during the so-called "commune", none of the IG PAS's chief directors was a member of the ruling party. And that speaks for itself.

Prof. Savarenskii commented on our conversation with Roman in one sentence: I must give you a powerful letter with recommendations. Indeed, after six months, after returning to Poland with a Master's Degree in Physics diploma in my pocket and with a strong letter of recommendation from Professor Savarenskii, I appeared on Pasteur Street in IG PAS. Roman had no choice. He had to hire me. At that time, Professor Savarenskii occupied a special place in the Soviet Union. He was a well-known scientist and an adviser on seismology in the Kremlin. In the seventies, the refusal to hire his student was downright dangerous. So, Roman hired me at his Institute but found a solution to neutralize my potentially unpopular political views. I was seconded to the Observatory in Belsk, where no seismology existed. But there were kind people, like Marysia Wernik, and there was a sound library, a beautiful forest, and peaceful and quiet surroundings. In short, I had perfect working conditions.

Soon and unexpectedly, Roman's attitude towards me changed dramatically. It happened after the trade union trip that I organized for the employees of the Observatory when, on the way to Krakow, we stopped at Jasna Góra in Częstochowa. The Institute was in turmoil. The Communist Party workers were outraged. Roman, the Director of the Institute, was under pressure. So, he called me and asked many questions, but from the beginning of this conversation, it was clear that he did not condemn me for the Częstochowa venture. At the end

of our meeting, he only told me that I should be more careful in the future. For him, it became clear: if I wanted to see Jasna Góra, I could not be a communist. This was the conclusion Roman drew from. From then on, I could always count on his help and kindness. And I often needed such help.

When, in 1982, during Martial Law, I could not return from the United States to Poland on the scheduled date, Roman, fearing that certain services would require him to fire me from the Institute, wrote a letter on my behalf asking for an extension of my stay. Also, with his money, he bought a return ticket to Warsaw and sent it to New York. How he managed to do it, he never told me. All this happened without my knowledge, as communication with the outside world was cut off during Martial Law.

There were more similar cases of help from Roman.

That was Roman. Selfless and always ready to help.

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Professor Roman Teisseyre – Reminiscence

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I met Professor Roman Teisseyre when I was a research assistant looking for a doctorate advisor. It is to be noted that at those times the so-called New Global Tectonics (presently the Plate Tectonics) and the theory of convection in the Earth's mantle had just begun to be developed. Being interested in such problems, it was difficult for me to find an advisor. I don't think any geophysicist in Poland was doing adequate research at that time. For the Professor, however, this was not a problem! He accepted my research topic without any hesitation. And he immediately impressed me with the openness of his mind and the scope of his scientific interests.

He demonstrated a similar wideness of horizons when he undertook the editing of the 6-volume monograph *Physics and Evolution of the Earth's Interior*[1]. In some respects, this work will remain a testament to a certain epoch. The development of geophysics has gone in a slightly different direction, which does not change the fact that this is a monograph where scholars will find the theoretical foundations of many areas of geophysics that are beautifully laid out.

But it's not about the Professor's scientific merits that I wanted to write here. That will probably be done better by others. I wanted to point out his ability to understand other people. And, at the same time, maybe make you laugh a little?

It once happened that I urgently needed to obtain Professor's signature on some documents. I no longer remember the details, but they are not important in this context. In any case, one late afternoon, with a folder of papers, I found myself at the door of his apartment (Filtrowa Street, Warsaw).

When I entered, it was immediately apparent that I came at a very good moment (from my point of view) because I found myself at a party with a dozen or so guests. The company, as expected at the Professor's home, was of a good international standard. The cordiality with which they welcomed me made me immediately feel like being among friends. The conversation in this rather mixed company did not prevent me from making generous use of the well-stocked table. My attention was quickly drawn to the platters, numbered (!) and filled with a variety of cheeses. As I approached them, a friendly lady appeared and handed me a piece of paper with a pencil and explained that a traditional competition for cheese experts was about to take place. You have to recognize what each cheese is called and write it on the slip of paper.

[1] International monographic series; 6 volumes, published between 1984 and 1992, Elsevier-PWN.

Whether there was a prize, I don't remember. In any case, I understood that I was among people for whom cheese is more than a piece of food. And that if I succeeded, I would impress the company a little.

Well, those times Poland was practically ruled by the man who, according to a popular joke, was a new Copernicus, since he "stopped the meat, moved the cheese, his name.....". Anyone who had the opportunity to live in those times will easily complete this rhyme[2]. But this does not change the fact that even in the heyday of communist Poland, the number of cheese varieties was quite limited. At the moment, I mostly remember the unusual green-blue and very salty rokpol. If I think carefully, the following still come to mind: gouda, oscypek (smoked sheep cheese), and edam. About the existence of many other cheeses in the world, one could figure out mainly from literature and movies. On my mind, there were some camemberts, roqueforts, cheddars, emmenthaler, and similar indefinite names. So, I completely didn't expect success, but it would have been silly to spoil the guests' fun. I started with the nearest platter....

After a while, my testing of cheeses was coming to an end. Finally, I sampled the last piece and handed the written note back to the Grand Jury.

I returned to the table, intending to continue getting acquainted with the delicious sandwiches and wine. In a few minutes or so, I saw the Professor, with a puzzled expression on his face, approach me and give secret signs. When we were in a safe corner, where the other guests could not hear us, the professor began to explain in a whisper:

– Mr. Leszek, hmm, silly thing, but you made a mistake only once! And you see, we have a guest here from France. This lady, at the window, our authority on cheese. A well-known connoisseur. Perhaps you would resign for her?

I didn't expect such a result! After all, I pointed out at least half of the cheeses at random. But at the same time, I felt a bit like Mrs. Miniver when Lady Beldon[3]'s granddaughter came to her with a somewhat similar request. However, I looked longer at the very distinguished old lady, and then I realized that indeed the only solution consistent with the rationale of this Universe is for her to win the competition. Any other solution would be a violation of the Laws of Nature and would be prone to cataclysm.

A quarter of an hour later, I approached the jury that held the written pieces of paper and said that I had made a mistake and would like to correct one cheese. The good-natured ladies agreed. Well, and I was able to make the proper corrections.

And by the end of the party, the world got a little better for this gourmet lady. She clapped with joy after the contest results were announced. Delighted, she said she hadn't lost her taste yet. She looked around and added that young people still have a lot to learn.

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[2] For those who don't speak Polish or are too young to remember: „wstrzymał mięso, ruszył serek, jego imię Edward Gierek", paraphrase to the saying about Copernicus, who „stopped the Sun, moved the Earth …". Edward Gierek was the First Secretary of the Polish Communist Party, de facto leader of Poland in 1970–1980, when there was a shortage of meat (note added in translation).

[3] Something should also be said about the film *Mrs. Miniver*, because the film (of 1942) is somewhat forgotten. And wrongly so. If one were to look for a film that served humanity the most, it would probably be this modest melodrama. Winston Churchill once said that this film had done more for the war effort than a flotilla of destroyers. In those hard times! The film also won 6 Oscars, but this is probably of interest only to film historians.

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Od Najbliższej Rodziny (Close Family Recollects)[1]

WSPOMINA SYN KRZYSZTOF

Najmilej wspominam Tatę z dzieciństwa. Wielce byłem dumny z Jego naukowej wyprawy do Wietnamu w 1957 roku. To był bardzo egzotyczny, niezwykle odległy kraj, a w tych latach niewiele jeździło się po świecie. Kiedy wracał, Mama wzięła mnie ze sobą do Szczecina, żebyśmy mogli go powitać. W naszym mieszkaniu na Filtrowej rządziła Babcia Włada, czyli matka mojej Mamy, Elżbiety. Babcia w rzeczywistości mieszkała na Żoliborzu, ale przyjeżdżała rano i wieczorem wracała na Żoliborz, więc miałem wrażenie, że jest zawsze z nami, w tym bardzo zatłoczonym w dawnych latach mieszkaniu. Ciężary domowych prac spadały na moją Mamę i na Babcię, to odciążało Tatę. Z pewnością właśnie Babcia ugadała chłopa, żeby przywoził mięso. Teraz powiedziałoby się: szara strefa. Szaro-buro był też odziany ów wysoki, małomówny chłop. Mówiło się o nim: „Pochwalony", bo tym słowem witał się, wchodząc do domu. Babcia podczas okupacji musiała ciężko pracować, bo nie miała źródła utrzymania. Była wdową po przedwojennym ważnym urzędniku bankowym i zarazem oficerze rezerwy. To, że jest wdową, zawdzięczamy Stalinowi i ochoczym wykonawcom jego pomysłów. To była okropna prawda, o której nie tak szybko się dowiedziałem.

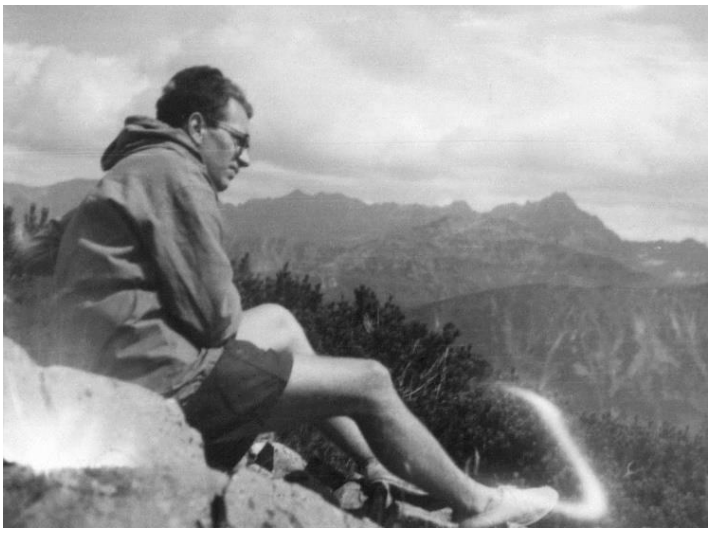
Z początku mieszkała z nami także druga babcia – zawsze pogodna babcia Wacia, mama Taty, z córką Izą, starszą ode mnie o kilka lat. Ta babcia była zawsze gotowa wygłosić jakąś żartobliwą sentencję, nawet wplatając łacinę w język polski, żeby było śmiesznie i mądrze. Babcia Włada była, można rzec, bliższa ziemi; też miała swoje powiedzonka, ale o zabarwieniu twardszym, jakby plebejskim. Nie dziwię się, że między dwiema Babciami, tak różnymi, „iskrzyło"; jednak były to spory przyjacielskie.

Jako dzieci dowiedzieliśmy się od Taty, że był w naszej rodzinie ważny uczony – Wawrzyniec Teisseyre, dziadek Taty, a więc ojciec naszego dziadka Kazimierza. Dowiedzieliśmy się też, że w innych miastach żyją czterej bracia Kazimierza. Trzech było naukowcami – Jerzy, Henryk i Andrzej, zaś Stanisław był malarzem.

Mama także studiowała fizykę. Wiem, że pomagała Tacie w pracowni krystalograficznej – może to ich zbliżyło? Oprócz fizyki połączyła ich pasja do Tatr. Wspinali się razem na Mnicha. Po ślubie też jeździli w Tatry. Mój brat twierdzi, że Tata odwiódł Mamę od wspinaczki, ja też tak przypuszczam.

Pamiętam długie wakacje w Kościelisku z Mamą, babcią Władą i czasami z Tatą, który dojeżdżał do nas, gdy mógł. Tam Mama była największą przyjaciółką górali. Prowadziła niespieszne rozmowy z naszą drogą Gaździną. Jeździliśmy więc do Kościeliska co roku, przez całe lata. Podczas tych wakacji, pierwszych lub drugich, urodził się mój brat Mikołaj, dokładnie w moje imieniny. Tak więc otrzymałem brata – zakopianina (jest z tego bardzo dumny). Tata

[1] English version in the Annex



Rodzice za młodu, w Tatrach.

był świetnym kompanem i w letnich, i zimowych wypadach, kiedy do nart zakładało się buciory, sznurowane. Kiedy byliśmy z bratem mali, Tata i stryj Jacek, o którym jeszcze będzie mowa, uczyli nas na nich jeździć. Mój brat Mikołaj (Misiek) czynił szybkie postępy; ja byłem oporny, gdy chodzi o styl. Misiek wyrósł na najlepszego narciarza w rodzinie. Tata na narty jeździł jeszcze długo – do osiemdziesiątki, a może i dłużej.

W Warszawie Ojciec nie miał dla nas tyle czasu, ile byśmy chcieli. Jednak istniał Jego wieczorny czas przeznaczony dla synów – wówczas Tata snuł długie opowieści o przygodach zwierzątek, np. fenków i niedźwiedzi, odcinkowe właściwie. Te krótkie opowiadania na dobranoc były barwne i wesołe. Z czasem współtworzyliśmy z Tatą te opowieści.

Mrówczej pracy Taty nie zauważałem – ot, kreślił sobie coś na kartkach, nawet w filharmonii. Albo – jak mi przypomniał przyjaciel z dzieciństwa – podczas hucznej zabawy Roman nagle wychodził do drugiego pokoju, by rozwikłać jakieś zagadnienie lub coś obliczyć. Tak samo bywało na rodzinnych spotkaniach. Tata nie grał wielkiego uczonego, podobnie jak jego starszy brat Mietek, który pracował na Politechnice Wrocławskiej. Nikt z rodziny i znajomych nie odgrywał też roli bohatera wojennego. O ich przeżyciach w Powstaniu Warszawskim i ogólnie o przeszłości nie mówiło się dużo. Takie były czasy.

Pamiętam, zawsze podziwiałem Tatę i Jego kumpli. Byłem pewny, że w pracy tych naukowców przyjaźń była największą wartością; spokojnie godzili ją z osobistymi ambicjami. Kiedyś, po latach, podczas wyjazdów w teren z Tatą, Tomkiem Ernstem, Markiem Górskim i Jurkiem Suchcickim przekonałem się, że moja młodzieńcza opinia była słuszna. Skład był zresztą różny. Co najmniej raz wziął udział w takiej delegacji Janusz Marianiuk z Obserwatorium w Belsku, który również pasował do grupy, a także dyrektor administracyjny Marian Hościłowicz, w roli zwykłego pracownika i tak samo było po koleżeńsku.

Tata był osobą towarzyską i lubianą. Do największych Jego przyjaciół należała Zośka Droste, sejsmolog. To była także najbliższa przyjaciółka Mamy. Kiedy Ją wspominamy, od razu przed oczami stają: Józwa (Józef Hordejuk), Wojtek Stopiński, państwo Gadomscy, Jankowscy, Gibowiczowie i inni. Z kolei Andrzej Zawada, wspaniały wspinacz i organizator, później sławny himalaista, należał do przyjaciół Taty jeszcze z wczesnej młodości. Był oczywiście również przyjacielem Mamy, no i nas – synów. Podobnie Tadeusz Siemek. Jego żona Danka była spokojniejsza i nie tak ironiczna jak reszta. Podobnie było z inną parą: to Olgierd Idźkowski zwany powszechnie Szakalem z powodu braku tuszy (nadrabiał ten brak humorem) i jego żona Hanka. Żona Andrzeja Zawady – aktorka Anna Milewska – oczywiście

To zdjęcie zrobiono w mieszkaniu Anny Milewskiej i Andrzeja Zawady, po ich ślubie. W górnym rzędzie Andrzej Zawada (trzyma rękę na głowie żony) i Jerzy Pruchnicki, w następnym od lewej moja babcia Wacława Teisseyre, następnie matka i siostra Andrzeja Zawady, dalej jego żona Anna Milewska i moja babcia Władysława Kowalska. W kolejnym rzędzie Tadeusz Siemek, dalej Danuta Siemkowa i ich dzieci: Maja i Tomek, następnie Krystyna Kozłowska i Mama. Leżą: Zdzisław Kozłowski (mąż Krystyny) i mój Tata.

dołączyła do przyjacielskiego grona. I byli jeszcze inni koledzy z dawnych lat, jak również znajomi i znajome ze strony Mamy. Bardzo nam się podobały te, chwilami głośne, przyjacielskie spotkania starszych – choć zasadniczo nie braliśmy w nich udziału. Zaś babcia Włada kwitowała je z przekąsem mówiąc: „Młodzież" się bawi.

Wśród rodziny i znajomych nie widziałem kultu stanowiska, tytułu, nie można było się wywyższać ani innych ludzi lekceważyć. Nie było także w dobrym tonie zapisywać się gdzieś dla wygody i o samym dobrym tonie też się nie mówiło.

Gdy już nie byłem dzieckiem, lecz młodzieńcem na studiach, raz tylko zapytałem Tatę, jaką mi radzi wybrać drogę życiową, z jakimi ludźmi być blisko. Ojciec z namysłem i jakby ostrożnie powiedział, że Jego zdaniem wspólnotę naukowców wiąże jeden cel, a jest nim odkrywanie prawdy; i dlatego są przyjaciółmi.

Czy Tata miał oprócz nart inne hobby? Owszem, majsterkowanie – sam wykonał półki, pawlacze, skomplikowane schody w domku na działce. Jednak Jego majstersztykiem było

skrócenie wielkiej brzozowej szafy. Nastąpiło wtedy spotkanie towarzyskie pod hasłem „Otwarcie szafy". Zbierał też znaczki. Książki, dobre, czytało się. Dopiero wiele, wiele lat później zacząłem rozumieć, że Tata pasjonował się różnymi dziedzinami fizyki i to było Jego największe, stałe hobby. Szedł wśród tych zagadnień, wszędzie starając się dojrzeć coś nowego, spojrzeć z innej strony. I pracować nad tą sprawą! Stąd taki Jego szacunek dla wielu badaczy. Z reguły każdy, z kim Tata pracował, stawał się jego dobrym kolegą lub przyjacielem.

Odwiedzaliśmy z rodzicami obserwatoria. Przede wszystkim to największe w Belsku, pięknie rozlokowane na dużym terenie, na skraju tajemniczego lasu. Tam pracował nasz ulubiony stryj Jacek Kowalski – krewny Mamy oraz inni przyjaciele naszej rodziny. Jacek zresztą świetnie kucharzył. Poznaliśmy również obserwatorium w Niedzicy oraz w Książu, przy wspaniałym zamku. Spodobały mi się tam ogromne, groźne podziemia, w których później umieszczono sejsmometry. Ważne było też Obserwatorium na Helu, tak blisko morza.

Ojciec, w różnych działach geofizyki, należał do pionierów. Był jednym z inicjatorów rejestrowania wstrząsów zachodzących w lodowcu. Wziął udział w pierwszych takich badaniach bezpośrednio na powierzchni lodowca. Był również wśród pionierów badania

Od lewego górnego rogu, zgodnie z ruchem wskazówek zegara: 1) Maciej Zalewski, polarnik i, zapewne, jego żona Marina; 2) Mieczysław Teisseyre – brat Taty; 3) Tata, Tadeusz Kowalski czyli Stryj Jacek oraz profesor Eijo Vesanen z Instytutu Sejsmologii Uniwersytetu w Helsinkach; 4) Outi – córka państwa Vesanen, jej matka Raija Irma Vesanen i ojciec Eijo, Konstanty Pielak, Tata.

wpływu ustrukturyzowanego ośrodka na przechodzące fale sejsmiczne – chodzi tu o ośrodek zawierający liczne drobne struktury (mniejsze od długości badanych fal). Zagadnienie to może prowadzić naukowca do trudnej tematyki skrętnych czyli rotacyjnych drgań i efektów w ośrodku ciągłym (lub na przykład w budowli!). Tej tematyce, w jej różnych aspektach, poświęcił ojciec wiele lat. Był tu badaczem, edytorem i autorem prac oraz inicjatorem wielu pomiarów i dociekań teoretycznych.

Tata często był zapraszany na wyjazdy naukowe, również Mama zaczęła z Nim jeździć. Najwspanialszy był nasz wyjazd całą czwórką do Japonii. Wtedy Tata poleciał tam w połowie 1965 roku, a my dołączyliśmy tuż przed Bożym Narodzeniem. Byliśmy tam razem do połowy czerwca 1966 roku, i nawet trochę zwiedziliśmy ten piękny kraj.

Instytut miał kiedyś swój jacht, a właściwie oceaniczną łódź badawczą o nazwie Sonda. Jej kapitan, Konstanty Pielak, również był przyjacielem moich Rodziców; Mama została matką chrzestną tej jednostki. „Sonda" służyła do geofizycznych pomiarów w morzach. Kiedy część badaczy, i część tematyki badawczej Instytutu Geofizyki przeszła do nowopowstającego Instytutu Oceanologii (co mój Tata popierał!), również ta łódź wraz z kapitanem zmieniła „barwy klubowe". Załączam wybór czterech fotek, z lat 70' lub 80', prawdopodobnie z wizyty „Sondy" w Helsinkach.

Rodzice stali się stopniowo podróżnikami. Interesowało Ich wszystko: architektura, muzea, lokalna kuchnia i występy folklorystyczne. Nie jeździli natomiast na zbiorowe wycieczki.

Po śmierci mojej Mamy, Tata znalazł nowy dom u boku Bogny, czyli Marii Jeleńskiej, która także pracuje w Instytucie. Po ślubie Bogna zaczęła jeździć z Tatą na Ich sympozja. Jeździli też do Buska, do sanatorium. Ich marzenia o dalekim wyjeździe, do Japonii – byłaby to dla Taty kolejna tam wizyta – rozbiły się o Jego ciężką chorobę. Wtedy Bogna stała się również opiekunką Taty w Jego długich zmaganiach.

Nawet długie i szczęśliwe życie kiedyś się kończy. Jak się powszechnie mówi: cudów nie ma, ale miłość, przyjaźń, życzliwość to właściwie są cuda. Mój Tata był na te cuda otwarty, i otrzymywał je.

Krzysztof Teisseyre

WSPOMINA SYN MIKOŁAJ

Wspominając naszych rodziców wracamy myślą do dzieciństwa, do świata dobrego, uporządkowanego, w którym oczywiste było dobro i zło. I chociaż wówczas żyliśmy skromnie, początkowo z sublokatorem w mieszkaniu, to fajne były to czasy, z poczuciem pełnego oparcia w ukochanych rodzicach.

Wspomnienia dzielę na dwie pory roku: Tata z nami (ze mną i bratem Krzyśkiem) w zimie i w lecie. Może bardziej zapamiętałem „Tatę zimowego". A zimy wówczas, w latach 1950–1960, były prawdziwe, nikt się nie pytał, czy na Boże Narodzenie będzie biało, bo to było oczywiste, że będzie śnieg i tak było. Zima, a więc sanki. Tata zaprzęgał się do sanek i wiózł nas, czasem podbiegając niczym koń pociągowy, przez park do ogródka jordanowskiego z usypaną górką do zjeżdżania. „Z drogi śledzie, bo Pan jedzie!" pokrzykiwali butni saneczkarze. Potem, gdy byłem starszy, to wspominam pierwsze łyżwy przykręcane do podeszwy zwykłych butów. Dzisiaj są to już okazy muzealne, podobnie jak drewniane narty z kandaharami. Potem miałem już prawdziwe łyżwy, wymarzone hokejki. A chodziło się na łyżwy często, bo lodowiska wylewano na pobliskim stadionie Skry, mróz długo trzymał, a odwilże stanowiły krótkie pauzy w śnieżnym świecie.

Potem narty, moja największa do dzisiaj pasja. Górami żyli oboje rodzice. Mama wspinała się w Tatrach, natomiast do nart nie miała smykałki. Tata na odwrót: od wspinaczki odwiódł

Tata z jednym z synów w Tatrach Zachodnich

Mamę, natomiast lubił narty. Byliśmy z Tatą, bratem i Izabelą – siostrą Ojca – na tygodniowym kursie narciarskim w schronisku Ornak w dolinie Kościeliskiej. Ćwiczyliśmy na półku na hali Smytniej, a także chodziliśmy na wycieczki (dzisiaj powiedzielibyśmy skitury) na przełęcz Iwaniacką i kolebkę narciarstwa, halę Pyszną. O nas mówili: „docent z pacholętami" (był nim już wówczas Ojciec), co oburzało Izabelę, wówczas już dorosłą panią. Potem były wyjazdy do doliny Chochołowskiej, do schroniska Blaszyńskich – dzisiaj leśniczówka. I znowu deptanie półek i wycieczki na Rakoń i do doliny Staroroboci ańskiej. W następnych latach to już zakwaterowanie w Zakopanem (raz udało się zdobyć miejsca w schronisku na Kondratowej) i powolne oswajanie Kasprowego. I tak płynęły lata, a nasza (moja i Ojca) miłość do nart nie przemijała. To Tata zaraził nas Dolomitami, chociaż nie wiem, czy w ostatnim czasie bardziej cenił sobie szusowanie czy klimatyczne górskie knajpki, które odwiedzał w przerwie na kawkę i bombardino. Potem to my, z żoną Joasią, zabieraliśmy Tatę na narty, które uprawiał przez długie lata.

A lato? – też oczywiście góry, najczęściej Tatry z pobytem u zaprzyjaźnionej gaździny w Kościelisku na Groniu. Wycieczki górskie, stopniowo coraz ambitniejsze. Gdy miałem 9 lat padły pierwsze dwutysięczniki – Czerwone Wierchy. Dzisiaj nie zliczę, ile to już razy na nich byłem i wcale mi się nie znudziły. A potem, gdy miałem 11 lat to zaliczenie pierwszych tatrzańskich łańcuchów – zdobycie Zawratu. Pamiętam, była wtedy mgła, która pomogła mi opanować lęk wysokości. Zejście z powrotem na Halę Gąsienicową to było dla mnie za dużo, a więc łagodnym szlakiem poszliśmy do Pięciu Stawów i dalej przez Świstówkę do Morskiego Oka, do którego wówczas dojeżdżały autobusy. W następnych latach były jeszcze Rysy. Po skończeniu moich studiów spędziłem tydzień, z Mamą i Tatą, w Tatrach Słowackich.

Do wspólnych wyjazdów z Ojcem w góry, w Alpy austriackie, wróciliśmy dopiero w obecnym tysiącleciu, po odejściu naszej ukochanej Mamy. Byliśmy w okolicach Dachsteinu nad pięknym jeziorem Gosau, a podczas następnego wyjazdu w dolinie Oeztal. Wracając do mojego dzieciństwa to wspomnę, że oboje Rodzice preferowali aktywny wypoczynek. Oprócz gór, były też akcenty wodne, raczej spływy kajakowe niż leniuchowanie na plaży. Na

wakacjach gościliśmy też w, rozsianych po Polsce, obserwatoriach geofizycznych, często mieszczących się w atrakcyjnych miejscach – jak zamki w Niedzicy i w Książu, a także nad morzem na Helu. Często odwiedzaliśmy też Belsk z Centralnym Obserwatorium Geofizycznym, położonym w sąsiedztwie rezerwatu Modrzewina.

Tata dużo wyjeżdżał za granicę. Były to zarówno wyprawy badawcze: Wietnam, Spitzbergen, jak i dłuższe pobyty z wykładami (Tokio, Trieste). Bardzo lubiliśmy z bratem słuchać Taty opowieści o Wietnamie, wzbogacanych o dowcipne anegdoty i kawały, jakie robili sobie wzajemnie uczestnicy wypraw. Przebojem stały się opowieści jak to jeden z uczestników wyprawy próbował w tym komunistycznym kraju wybudować kościół, a inny doktor wyprawy szpital swojego imienia.

Fizyka była największą pasją Taty, ale miał też inne zainteresowania. Lubił z Mamą spędzać wolny czas na działce w Zambskach nad Narwią, w skromnej, ale uroczej chatce kurpiowskiej. Kochał zwierzęta – owczarki niemieckie Agisa i Aresa oraz czarną kotkę Pipi. Rodzice prowadzili towarzyskie życie, ale to Mama była inicjatorką spotkań ze znajomymi, w większości pracującymi z Tatą. Nie zapomnimy wspaniałych imienin Rodziców i innych spotkań, na które zapraszali pod zabawnymi hasłami. Tata był pasjonatem swojej pracy, my z bratem nie poszliśmy w Jego ślady, ale jako lekarz mam uznanie dla fizyki i matematyki – królowych nauk ścisłych. Zainteresowania i może też zdolności przeskakują przez pokolenia. Mój starszy syn Paweł został naukowcem matematykiem, a młodszy Piotr, po studiach na socjologii, zajmuje się analizą danych. Tata, podobnie jak i ja, może być z Nich dumny.

Mikołaj Teisseyre

WSPOMINA ŻONA BOGNA

MÓJ MĄŻ, PROF. ROMAN TEISSEYRE

Roman Teisseyre – światowej sławy naukowiec, powszechnie szanowany.

A jakim był mężem i człowiekiem?

Był człowiekiem przez duże C i takim był Mężem. Przede wszystkim był pogodny i pełen optymizmu. Rano, gdy się budził, natychmiast zaczynał śpiewać. A ponieważ nie miał ani słuchu, ani głosu, to Jego poranne występy mogłyby być uciążliwe, gdyby nie to, że były szalenie zabawne. Układał tekst do wyśpiewywanych melodii, zawsze inny, zawsze zabawny, chociaż często zupełnie bez sensu, pełen absurdu w stylu Monty Python'a.

Żył bardzo intensywnie. Mimo, że praca naukowa ogromnie Go absorbowała, zawsze miał czas i ochotę na spotkanie towarzyskie, kino, koncert czy wystawę. Bardzo lubił chodzić do restauracji. Ale też wykorzystywał każdą wolną chwilę na pracę w domu. Potrafił usiąść do komputera na 15 minut pomiędzy innymi zajęciami. Z tych 15-minutówek składały się godziny.

Musiał mieć koszule z kieszonką i w tej kieszonce lądowały skrawki papieru, na których zapisywał swoje pomysły, które przychodziły Mu do głowy na koncercie, na spacerze czy na proszonym obiedzie.

W codziennym "repertuarze" Romka były cztery stałe punkty: poobiednia 15–20 minutowa drzemka, potem gimnastyka – kilka minut, prysznic, a następnie spacer. Poobiednia drzemka była obowiązkowa. Moi przyjaciele już wiedzieli, że Romkowi trzeba zapewnić miejsce do spania po obiedzie. Gimnastyka, prysznic i spacer były czasami pomijane, bo trudno brać prysznic w cudzym domu, kiedy jest się na proszonym obiedzie.

Romek bardzo lubił chodzić na zakupy. Czarował wszystkie panie ekspedientki. Rozpromieniały się na Jego widok, a On pytał: „Co Pani ma dziś dobrego dla mnie? " Zawsze dostawał coś słodkiego – cukierek, czekoladkę czy ciasteczko. Na zakończenie zakupów oświadczał: „Ja nie płacę" i ten obowiązek spadał na mnie. A że czasami Jego kartą, nie miało to już znaczenia.

Miał swoiste poczucie humoru. Bardzo lubił żartować, również na swój temat.

Był miłośnikiem Podkowy Leśnej, gdzie mieszkaliśmy przez ostatnie siedem lat. Podkowa Leśna oczarowała go od pierwszego wejrzenia, kiedy to, w ogrodzie przy kościele św. Krzysztofa, zobaczył pawie. To oczarowanie tylko się pogłębiło, kiedy poszliśmy do świetnej, lokalnej restauracji oraz gdy zaczął chodzić na długie spacery.

Romek kochał życie i potrafił się nim cieszyć każdego dnia. Zachwycał Go kolor nieba, kształt obłoków, tysiące drobiazgów, z których czerpał radość. Nigdy nie narzekał. Zawsze powtarzał: „Wszystko będzie dobrze", a jeśli nie było dobrze, kwitował to stwierdzeniem: „Takie jest życie".

Maria Teisseyre-Jeleńska

WSPOMINA SIOSTRA IZABELA

Mam wspaniałą rodzinę, męża, dzieci, wnuki, ale teraz wspominam tę z dzieciństwa.

Mama – romantyczna marzycielka z pogardą dla dóbr doczesnych, anioł dobroci. Pamiętam Jej opowieść: Stojąc na mostku nad potokiem bawiła się drogocennym pierścionkiem obracając go na palcu; gdy wpadł do wody, pierwszą Jej reakcją był wybuch niepohamowanego śmiechu. Usiłowała wpoić we mnie zamiłowanie do literatury, sama dużo czytała, a w przerwach szukałyśmy okularów lub zegarka (raz był w lodówce).

Tata też był romantykiem, bardzo lubiłam z nim rozmawiać – snuł marzenia o świecie bez granic i wojen; pierwszym etapem miała być zjednoczona Europa. Mówił też, że handel nie jest zajęciem do końca uczciwym. Myślę o tym sprzedając rzeczy na OLX.

No i mój brat Romek – ideał. Zresztą nie była to tylko moja opinia. Kiedyś, kiedy byłam już mężatką, bawiłyśmy się w gronie znajomych w wyliczanie wad naszych mężów; każda z nas miała dużo do powiedzenia. Gdy przyszła kolej na Elkę – żonę Romka, chwilę pomyślała i oświadczyła zdecydowanie: nie ma żadnych.

I rzeczywiście, Romek odziedziczył po naszych rodzicach, najlepsze cechy: bezinteresowność, życzliwość, chęć pomocy i bardzo charakterystyczne, niesłabnące z wiekiem, ogromne poczucie humoru, w myśl sentencji Monteskiusza: „Powaga jest pancerzem głupców". Nie pamiętam, żeby o kimś źle się wyrażał, czy też komuś czegoś odmówił. Był dzielny i odważny, gdy zachodziła taka konieczność, i nigdy nie narzekał. Jednocześnie był bardzo wrażliwy, bał się urzędów, oficjalnych wystąpień i konfliktów. Jak wychodził z mieszkania naszej mamy, to sprawdzał parę razy czy gaz jest wyłączony. Taki bliski, kochany człowiek. Opowiadał mi o fizyce, to było fascynujące: szybko porzuciłam pisanie kolejnej niedokończonej powieści (z inspiracji mamy) i za jego sprawą zostałam fizykiem.

Miałam też drugiego brata, Mietka, trzy lata starszego od Romka. Mieszkał we Wrocławiu i znacznie mniej go znałam. Pamiętam, że zawsze był „duszą towarzystwa". Bardzo lubiłam jeździć z Mamą do Niego, bo bawiłam się wtedy z bratankiem Ryśkiem (trzy lata młodszym). W nocy wykradaliśmy się do ogródka konstruując niespodzianki dla rodziców, którzy nie zawsze byli zachwyceni.

W sumie, cała rodzina była wspaniała. Cechowało Ją lekceważące podejście do wartości materialnych, nigdy nie było mowy o problemach finansowych ani niesnasek z tego powodu, ogromne poczucie humoru i optymizm w każdej sytuacji, silne więzi rodzinne – rodzina była święta. Bogaci nie byliśmy, to były biedne czasy. Pamiętam dzieciństwo – mieszkanie na Filtrowej – trzy pokoje: ja z mamą, brat z żoną i dwójką dzieci + teściowa na przychodne + całkiem obca rodzina, czyli inni lokatorzy: małżeństwo z synem (bawiłam się z nim). Kuchnia była wspólna, podobnie łazienka; ciepła woda dwa razy w tygodniu. Było znośnie, a nawet wesoło. Często bywali koledzy Romków, bardzo ich lubiłam. Lubiłam też ostatnie dni miesiąca, gdy jadłyśmy z mamą jedynie chleb maczany w oleju z solą – pycha!

Pamiętam moje zwariowane wesele na Filtrowej (dużo później, nie było już lokatorów): rzucanie kulkami tatara, oblewanie wodą, przebieranki i tańce. Pełno było takich imprez rodzinnych – zwariowanych i beztroskich.

A Romek niemal do ostatnich dni pracował, miał nowe pomysły, o których mi opowiadał, nie wszystkie całkiem trafne, ale fizyka do końca go pasjonowała, była jego życiem. Rozumiem to teraz, gdy myślę z lękiem, co będę robić, gdy już nie będę mogła pracować.

Po latach ma się tendencje do idealizacji. Może moja rodzina nie była do końca taka idealna, była zwariowana i beztroska, ale najważniejszego mnie nauczyła: przede wszystkim liczy się człowiek.

Izabela Gorczyca

WSPOMINA BRATANEK RYSZARD

Parę słów o moim stryju Romanie Teisseyre

Brat mojego ojca był mi znany od wczesnego dzieciństwa. Często bywałem z rodzicami w Warszawie, gdzie Roman mieszkał z rodziną. Bywał On też we Wrocławiu rozśmieszając nas wszystkich ciętymi dowcipami i anegdotami. Z dobrego humoru to był On od dawna znany. Jego wstawki, komentarze i przygadówki zawsze były na inteligentnym poziomie, tak jak i praca oraz twórczość naukowa.

Znane też było zamiłowanie Stryja do turystyki i sportu, szczególnie narciarstwa. Mój tato, a jego brat, też zapalony narciarz, zabierał mnie, już jako małego chłopca, w góry i ostro do nart sposobił. I tak to wiele razy były okazje do wspólnych szusowań na różnych stokach naszych wspaniałych gór, najczęściej w Karkonoszach, bo naturalnie z Wrocławia to najbliżej. Razu pewnego – jak sobie przypominam – Stryj zorganizował wyjazd z Warszawy do Szklarskiej Poręby zabierając mego ojca i mnie, ucznia liceum na ten czas. Był to kwiecień i nadzwyczajnie ciepło. Zatrzymaliśmy się w Szklarskiej i Hala Szrenicka była naszą areną.

Wtedy wydarzyła się zabawna przygoda. Po wielu godzinach zjazdów postanowiliśmy wrócić do miasta. I tu Romek wpadł na pomysł – po co schodzić piechotą, zjedziemy przez las z boku hali. Tak zrobiliśmy do momentu, aż drogę przeciął wartki strumień. Stryj niewiele myśląc zdjął narty i podciągając nogawki spodni wkroczył do wody. Ojciec zrobił to samo, a ja próbowałem skakać po skałkach z nartami pod pachą, co było dosyć trudne. Romek był już na brzegu i dowcipnie sumował nasze wysiłki. Założyliśmy narty i powoli dalej przez las. A tu nagle druga odnoga strumienia przecina nam drogę, jeszcze szersza i głębsza. Stryj nadal dowcipkuje, tato warczy. Znów przeprawa i Roman wpada w dziurę mocząc się do pasa ku uciesze i prowokując komentarze brata. Teraz narty na ramię i idziemy pieszo, a tu znów zagradza drogę woda. Widać, że strumień rozdziela się na równoległe odnogi i tak dzieje się jeszcze trzy razy!! Bracia zaczynają niecenzuralne uwagi i przy piątej odnodze postanawiamy iść wzdłuż, bo nie mieliśmy już ochoty na kolejne moczenie. I tak po 15. minutach marszu dochodzimy do mostku (!) – miejsca, gdzie odnogi się schodzą w jeden nurt!!! Wystarczyło więc, pójść na początku 200 m wzdłuż wody i … nie przytoczę tu komentarza Pana Profesora. Jeszcze godzinka marszu i byliśmy u celu. A Stryj i tak twierdził, że pomysł miał odkrywczy.

A tak w ogóle, to Stryj Roman był bardzo czułym, ciepłym, choć czasem ostrym, mentorem i profesorem, lubianym przez pracowników i kochanym przez rodzinę i mnie.

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E – Hydrology (formerly Water Resources)

P – Polar Research

M – Miscellanea

Every volume has two numbers: the first one is the consecutive number of the journal and the second one (in brackets) is the current number in the series.

This Special Issue of our journal is a tribute to the memory of Professor Roman Teisseyre, one of the pioneers of modern geophysics, who passed away on November 21, 2022. His whole scientific career was associated with the Institute of Geophysics, PAS. We recollect the achievements of this Prominent Scholar, as well as Roman as a person and friend.

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ANNEX

ROMAN TEISSEYRE IN MEMORIAM
English version of the close relatives' recollections
(published in electronic edition only)

SON KRZYSZTOF RECALLS

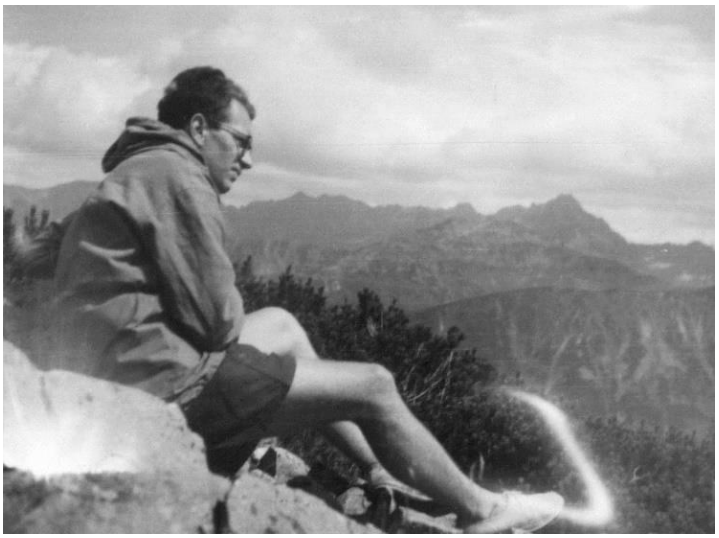
I recall my Father most nicely from childhood. I was so proud of his scientific expedition to Vietnam in 1957. It was a very exotic, remote land – and travelling was rare in those years. Upon his return, Mummy took me to Szczecin (a port city), so we could welcome him.

In our flat on Filtrowa Street (Warsaw), Grandmother Władysława (Vlada), mother of my mother Elżbieta, ruled. Although she lived in another district of Warsaw, Żoliborz, she used to come each day very early and leave in the evening; it looked like she lived with us in this quite crowded home. I mean *crowded* because one of the three rooms was occupied by another family of three people. Weights of the household chores fell on my Mother and grandmother; it relieved Dad. Certainly, it was my grandmother who arranged for a peasant to supply us with the meat. Nowadays, it could be called a *gray area*. And indeed, this tall, taciturn peasant always wore grayish clothes. He was unofficially nicknamed Praised (Pochwalony), as he spoke „Praised be", entering our home. During the German occupation time, grandmother Vlada had to work hard. She was a widow of a pre-war officer (a bank manager in peacetime). It was Stalin's fault that she was a widow, Stalin's and his willing followers. I learned this terrible, awful truth not so early.

In our early years, also the second grandmother lived with us – always cheerful Wacława (Vatsia) with her daughter Izabela, a few years older than me. She was always ready to make a funny remark, even to inweave Latin into Polish. Grandmother Vlada was, let us say, more down-to-earth. She also had her sayings which were more brutal and plebeian-like. Unsurprisingly, arguments used to spark between grandmothers, but their squabbles were friendly.

As children, we learned that there was a significant scientist in our family. It was Wawrzyniec Teisseyre, Dad's Grandpa – father of our Grandpa Kazimierz. We also learned that the four brothers of Kazimierz lived in other cities. Three of them were scientists: Jerzy, Henryk, and Andrzej; only Stanisław was a painter.

My Mum studied physics, too. Most probably, she helped Dad in the crystallographic laboratory. Besides physics, it was also the passion for mountains that brought them together. Specifically, the devotion to the Tatra Mountains. They climbed together at the Monk (Mnich in Polish). After marriage, they still used to travel to the mountains. My brother says that it was Dad who pulled Mum away from climbing; I also think that was the case.



My parents in their youth, in the Tatra Mountains

I remember long holidays in Kościelisko (a village in front of the Tatra Mountains, near the town Zakopane) – with my Mother, grandmother Vlada and occasionally Father – he used to join us whenever he could. Mummy was the greatest friend of the local people. She used to have unhurried conversations with our beloved landlady (Gaździna). We used to relax in Kościelisko each summer, for many years. During these holidays, the first or the second, my brother Mikołaj was born, exactly on my name day. Thus, I was given a brother – a Zakopaner (he is very proud of this). In the summer or winter excursions, our Father was a great companion. In the winter time, we used to put on big lace-up boots for skiing. Because, when we were very young, Dad and our uncle Jacek taught us to ski. Mikołaj (Misiek) was progressing rapidly, while I had problems when it came to the style. Misiek has grown up to be the best skier in the family. Our Father used to ski for a long time – up to his eighties.

In Warsaw, our Father didn't have as much time for us as we wished. However, there was his special time for us – the evenings. At that time, he used to tell us stories about the adventures of animals – the Fennecs and the Bears; in the episodes. Those good-night stories were joyful, full of colors and shades. With time, we began to participate in their creation.

I have not seen the unremitting work of my Father: he used to scribble something on a loose piece of paper, even in the Philharmonics. Or – as an old friend reminded me – during loud parties, it happened that Roman suddenly changed the room to find a solution to a scientific problem. It used to be the same at the family meetings.

Neither our Father nor his older brother Mieczysław (Mietek), who worked at the Wrocław University of Science and Technology, has played a great scholar. Also, nobody in the family, or among close friends, played a wartime hero. Some of them were participants in the Warsaw Uprising, some – only witnesses, but nobody was talking about it. Times were like that.

I admired our Father and his colleagues and was convinced that of the biggest value in their work was friendship, in total harmony with their personal ambitions. After the years, during field trips with him and Tomasz Ernst, Marek Górski, Janusz Marianiuk, and Jerzy Suchcicki, I realized that my youthful opinion was correct.

Dad was a sociable and likeable man. Zofia Droste (Zośka) belonged to his greatest friends; she was a seismologist and also the closest friend of my Mother. When I think about her, other people immediately stay before my eyes: Józef Hordejuk (Józwa), Wojciech Stopiński, Mr. and Mrs. Gadomski, Jerzy Jankowski, Sławomir Gibowicz, and others, including Andrzej Zawada,

This photo was taken in the flat of Anna Milewska and Andrzej Zawada, after their wedding. In the uppermost row: Andrzej Zawada (he keeps his hand on his wife's head) and Jerzy Pruchnicki; in the next row: my grandmother Wacława Teisseyre, further on – mother and sister of Andrzej Zawada; his wife Anna Milewska and my grandmother Władysława Kowalska. Next row: Tadeusz Siemek, his wife Danuta, and their children Maia and Tomasz, then Krystyna Kozłowska and my mother Elżbieta Teisseyre. Below, lying: Zdzisław Kozłowski (husband of Krystyna) and my father Roman Teisseyre.

who belonged to my father's friends starting from their young years. Of course, he was also a friend to my Mother and us – the sons. The same was with Tadeusz Siemek and Olgierd Idźkowski. These two were jokers; their wives were quieter. Andrzej Zawada was a great climber and leader of high-mountain expeditions; he became a well-known Himalayan climber. His wife Anna Milewska, an actress, joined the group of friends. Me and my brother liked those loud meetings of my parents' friends, even though we didn't participate in them. Our grandmother Vlada used to comment on such meetings: The "youngsters" are having fun…

I never noticed, in my family and among their close friends, any cult of position or title. It was not appropriate to boast or disregard other people. It was also not in good taste to enroll somewhere for convenience (or even to talk about good taste).

When I was not a child anymore, I asked my Father about my future way of life only once. Father, thoughtfully, said that he regards the scientists as the people who are bonded by one common goal – to discover the truth. And they are friends with each other, just for this reason.

Whether our Father had any hobbies besides skiing? Oh yes – it was handcrafting. He made shelves and cubbyholes. He also built stairs in our country house. However, the shortening of the big birch wardrobe appears to be his masterpiece. For this occasion, a meeting under the slogan "Opening of the wardrobe" was held. He also used to collect stamps. Later, after many years, I realized that the real hobby of my Father was physics: various branches of this science. He used to explore them in order to try to see something new everywhere; to look from a new side. Therefore, he had respect for other researchers. As a rule, everyone who cooperated with him became his friend or a good colleague.

We used to visit, with our Parents, the Polish observatories. First of all, the biggest one – the Central Geophysical Observatory in Belsk. It is beautifully deployed in a large area, on the edge of a mysterious forest. Our beloved uncle Jacek Kowalski (he was a relative of our Mother) worked there, among some other friends of our parents. We also visited other Observatories – the one in the Niedzica castle, the one at the seaside in Hel, and the observatory on the grounds of the Książ Castle. This is a huge, very interesting castle. There, I liked the dangerously looking undergrounds (where the seismometers were transferred to, later).

From the upper left corner clockwise: (1) Maciej Zalewski, polar explorer from the Institute of Geophysics PAS, and his wife Marina; (2) Mieczysław Teisseyre, our Father's brother; (3) our Father, Tadeusz Kowalski (Uncle Jacek), and Prof. Eijo Vesanen from Institute of Seismology, University of Helsinki; (4) sitting by the table: Vesanens' daughter Outi, her mother Raija Irma, and father Eijo, Konstanty Pielak, and our Father.

In various fields of geophysics, our Father belonged to the pioneers. He was one of the initiators of the study of icequakes occurring in the glacier. He participated in the first experiments with seismometers placed directly on the glacier's surface. He was also among the pioneers in studying the effect of a structured medium on seismic waves passing through this medium – that is, a medium containing numerous fine structures (smaller than the wavelengths being studied). Such research has led to complicated problems related to torsion or rotational waves and effects in a continuous medium (or, for example, in a building!). To this subject, in its various aspects, my Father devoted many years. He was a researcher, initiator of experimental and theoretical projects, as well as an editor and author of many publications.

Our Father used to be frequently invited to conferences and research stays. Our Mummy also started to travel with him. Our stay in Japan in 1965/1966 is my favorite. We even traveled a bit through this beautiful country.

The Institute owned, at a certain time, a boat destined for scientific explorations; it was called Sonda. Its captain Konstanty Pielak was also a friend of my parents. My Mother became the godmother of this boat. Sonda was used for geophysical measurements in the seas. When some researchers and some research topics of the Institute of Geophysics were transferred to the newly established Institute of Oceanology (which my Dad supported!), also this boat, along with its captain, changed "club colors". I enclose a selection of four photos, from the 70' or 80', probably from Sonda's visit to Helsinki.

Parents have gradually become travelers. Everything interested them: landscapes, architecture, museums, regional cuisine, and folk performances. They were not interested in organized trips.

After our Mother's death, Father found a new home with Bogna, officially: Maria Jeleńska, who still works at the Institute. After the wedding, she started to go with him to scientific meetings – her and his. They also liked the sanatorium in Busko. Their dreams for longer trips have been broken by the Father's illness. During this time, Bogna also became his caretaker.

Even a long and happy life ends at a certain point because, as it is commonly said, there are no miracles. But love, friendship, and goodwill are, in fact, miracles! My Father was open to these miracles and received them with gratitude.

Krzysztof Teisseyre

Translated by Bartosz Woźniak

SON MIKOŁAJ RECALLS

Recalling our parents, we think back to our childhood, to a good, orderly world in which good and evil were obvious. Although we lived modestly back then, initially with a subtenant in the apartment, those were fun times with a sense of full support from our beloved parents.

I divide my memories into two seasons: Dad with us (me and my brother Krzysiek) in the winter and in the summer. I may have remembered the winter Dad more. And the winters back in the 1950s and 1960s were real; no one asked if it would be white for Christmas because it was obvious that there would be snow, and there always was. Winter, then, meant sledding. Dad would harness himself to the sled and take us, sometimes running up like a draft horse through the park to a Jordan garden with a hill piled up for sliding. "Z drogi śledzie bo Pan jedzie" ("Herrings, get out of the way, the King is coming"), shouted the haughty sledders. Then, when I was older, it was the first skates screwed to the soles of ordinary shoes. Today, they are museum specimens, just like the wooden skis with Kandahar bindings. Then, I already got real skates, the hockey skates of my dreams. We used to go skating often because the ice rinks were poured at the nearby Skra stadium, the frost lasted for a long time, and the thaws were short pauses in the snow world.

Dad and one of his sons in the Tatra Mountains

Then there is skiing, my greatest passion to this day. Both of my parents lived and breathed mountains; Mom used to climb in the Tatra Mountains, while she had no knack for skiing. Dad was the other way around: he talked Mom out of the climbing, while he liked skiing. Me and my Dad, my brother, and Izabela (my Dad's sister) took a week-long ski course at the Ornak hostel in the Kościeliska Valley. We used to practice on the field in Hala Smytnia and also used to go on trips (now would be called ski tours) to the Iwaniacka Pass and to the cradle of skiing – Hala Pyszna. They called us "the docent with the younglings" (my Dad was a docent by then), which outraged Izabela, who was already an adult at the time. Then there were trips to the Chochołowska Valley to the Blaszyńskis' shelter – today a forester's lodge. And then again tramping the fields and going on trips to Rakoń and the Staroroboci ańska Valley. In the following years, we used to rent an accommodation in Zakopane (we once managed to get a place in the shelter on Hala Kondratowa), slowly getting used to skiing at Kasprowy Wierch. And so the years were passing and my Dad's and my love for this sport did not fade away.

It was Dad who enthused us with the Dolomites, although I don't know what he appreciated more at the time – whether it was skiing or going to mountain pubs he used to visit during breaks for coffee and bombardino. Much later, it was my wife Joasia and me who used to take Dad skiing, which he enjoyed for many years.

And summers? It also meant, of course, the mountains, most often the Tatra Mountains, with a stay in the Kościelisko on Groń at the place owned by a local landlady (gaździna), a friend of ours. The mountain trips had gradually been more ambitious. When I was 9 years old, I climbed my first two-thousander – Czerwone Wierchy. Today, I can't count how many

times I've been on them, and I'm not bored of them at all. And then, when I was 11 years old, I completed the first Tatra chains – conquering Zawrat. I remember that there was a fog at the time, which helped me overcome my fear of heights. Descending back to Hala Gąsienicowa was too much for me, so we took a gentle trail to the Pięciu Stawów Valley and then through Świstówka to Morskie Oko, which was then served by buses. In the following years, there was also a visit to Rysy, and during our return from Japan, already in France, a mountain trip with Andrzej Zawada. Later, in the summer of 1968, my parents, brother, and I travelled around Europe: to France and northern Italy, returning through the Austrian Dolomites. After finishing my studies, I spent a week with Mom and Dad in the Slovak Tatras.

We returned to the joint trips to the mountains, to the Austrian Alps, together with my Dad in the current millennium, after our beloved Mom passed away. We were in the Dachstein area at the beautiful Gosau lakes and, during the next trip, in the Ötztal Valley. Going back to my childhood, it is obvious that both of my parents preferred active recreation. In addition to the mountains, there were also water accents, kayaking rather than lazing on the beach. On vacation, we also visited geophysical observatories scattered around Poland, often located in attractive places such as castles in Niedzica and Książ, as well as by the sea on Hel. We also frequently visited Belsk with its Central Geophysical Observatory, located in the vicinity of the nature reserve in Modrzewina.

Dad travelled abroad a lot. His journeys included both the research trips (to Vietnam and Spitsbergen), as well as longer stays with lecturing (Tokyo, Trieste). My brother and I really enjoyed listening to Dad's stories about Vietnam, enriched with humorous anecdotes about the pranks that the expedition participants used to play on each other. Some of those stories became hits, like the one about an expedition participant who tried to build a church in this communist country, and another about an expedition doctor who tried to build a hospital named after him.

Physics was Dad's greatest passion, but he also had other interests. He enjoyed spending his free time with Mom on a plot of land in Zambski by the Narew River in a modest but charming cottage (in Kurpie style). He loved animals, German shepherds Agis and Ares and the black cat Pipi. Parents led a social life, but it was Mom who was the initiator of meetings with friends, most of whom worked with Dad. We will never forget our parents' wonderful name days and other gatherings to which they used to invite guests under funny slogans.

Dad was passionate about the field of science he chose, but neither my brother nor I followed his footsteps, although as a medical doctor I have an appreciation for physics and mathematics – the queens of the sciences. Interests, and perhaps abilities as well, jump across generations. My older son Paweł became a math scientist, and the younger one, Piotr, after studying sociology, is involved in data analysis. Dad, like me, can be proud of them.

Mikołaj Teisseyre

Translated by Bartosz Woźniak

WIFE BOGNA RECALLS

MY HUSBAND, PROFESSOR ROMAN TEISSEYRE

Roman Teisseyre – a world-renowned, widely respected scientist. And what husband and man has he been?

He was a Man with a capital M and such a Husband, very cheerful and full of optimism. In the morning, just upon waking up, he would immediately start singing. And, as he had neither a musical ear nor a vocal talent, his morning performances could have been a nuisance if they were not so entertaining. He would arrange the text to the melodies he sang, always different, always funny, although often wholly pointless, full of Monty Python-style absurdity.

Romek led a very active life. Although the work on scientific problems absorbed him a lot, he always had time and desire to socialize, go to the cinema, a concert or an exhibition. He was very fond of going to restaurants. But he also used every free moment to do science at home. He was able to work on the computer for 15 minutes between other activities. Those 15-minute spans made up hours.

He had to have shirts with a pocket, and in this pocket landed scraps of paper and a pencil to enable him to write down the ideas that might come to him at a concert, on a walk or at an invited dinner.

There were four fixed points in Romek's daily "repertoire": a post-lunch 15–20 minute nap, then gymnastics – a few minutes, a shower, and then a walk. The post-lunch nap was mandatory. My friends already knew that Romek needed to be provided with a place to sleep after lunch. Gymnastics, showering and walking were sometimes skipped, because it's hard to take a shower in someone else's house when you're at an invited dinner.

Romek was very fond of going shopping. He charmed all the saleswomen. They beamed while seeing him, and he used to ask: "What do you have for me today?" and he would always get something sweet – a candy, a chocolate or a cookie. At the end of shopping, he often declared: "I don't pay", and this duty fell on me. It did not matter, though, that I could have used his card.

He had a peculiar sense of humor. He was very fond of joking, including jokes about himself.

He was a lover of Podkowa Leśna (suburb of Warsaw), where we lived for the last seven years. Podkowa Leśna enchanted him at first sight, when, in the garden by the St. Christopher's Church, he saw peacocks. This enchantment only deepened when we went to a great local restaurant and when he started going for long walks.

Romek loved life and was able to enjoy every day. He was enchanted by the color of the sky, the shape of the clouds, and thousands of little things he enjoyed. He never complained, always saying: "Everything will be fine", and if things were not fine, he commented: "Such is the life".

Maria Teisseyre-Jeleńska

Translated by Anna Dziembowska

SISTER IZABELA RECALLS

I have a wonderful family, a husband, children, and grandchildren, but now I am recalling the one from my childhood.

Mom – a romantic dreamer with contempt for material possessions, an angel of goodness. I memorized such a story: Standing on a bridge over a creek, she was playing with a precious ring by spinning it on her finger; when it fell into the water, her first reaction was a burst of uncontrollable laughter. She tried to make me love literature; she read a lot herself, and permanently kept looking for glasses or a watch (once it was in the refrigerator).

Dad was a romantic, too, and I enjoyed talking with him very much – he dreamed of a world without borders and wars; the first stage was to be a united Europe. He also suggested that trade was not an entirely honest business. I think about this when selling things on OLX.

And then there was my brother Romek – the ideal. Anyway, this was not just my opinion. Once, when I was already married, we used to play in the circle of acquaintances in listing the flaws of our husbands; each of us had a lot to say. When it was the turn of Romek's wife Elka, she thought for a moment and declared emphatically: there are none.

And indeed, Romek inherited from our parents the best qualities: selflessness, kindness, willingness to help and a very characteristic great sense of humor, which does not diminish with

age, according to the Montesquieu maxim: "Seriousness is the armor of fools". I don't remember him speaking unfavorably of anyone, or refusing when he could help. He was brave and courageous when necessary, and never complained. At the same time, he was very sensitive, afraid of offices, official appearances and conflicts. When he was leaving our mother's apartment, he would check a few times to make sure the gas was off. Such a close, loving man. He used to tell me about physics; it was fascinating. I quickly abandoned writing another unfinished novel (inspired by my mother) and became a physicist due to him.

I also had a second brother, Mietek, three years older than Romek. He lived in Wrocław and I knew him much less. I remember that he was always the "soul of the company". I really liked to go with Mom to visit him, because I was playing with my nephew Rysiek (three years younger) at the time. At night, we would sneak out into the garden, inventing surprises for his parents, who were not always pleased with it.

All in all, the whole family was wonderful, characterized by a light-hearted approach to material values, never a question of financial problems or disagreements over this. We were not rich, these were poor times. I remember my childhood – an apartment on Filtrowa Street – three rooms: me with my mother, my brother with his wife and two children + mother-in-law on the incoming + other tenants, i.e., a family completely unrelated to us: a married couple with their son (I played with him). The kitchen was shared, as was the bathroom; hot water twice a week. It was tolerable and even cheerful. Romek's friends were often there, I liked them very much. I also liked the last days of the month, when my mother and I ate only bread dipped in oil with salt – yummy!

I remember my crazy wedding on Filtrowa Street (the compulsory tenants had already moved away): throwing tartar balls, splashing with water, changing funny clothes and dancing. There were plenty of such family parties – crazy and relaxing.

Romek worked almost until his last days; he had new ideas, which he told me about, not all of them quite accurate, but physics was his passion to the end; it was his life. I understand this now when I think with anxiety about what I will do when I can no longer work.

As years go on, one has a tendency to idealize. Maybe my family wasn't quite so ideal, it was crazy and not always serious, but it taught me the most important thing: first and foremost, it's the people that matter.

Izabela Gorczyca

Translated by Anna Dziembowska

NEPHEW RYSZARD RECALLS

A few words about my uncle Roman Teisseyre

My father's brother was known to me from early childhood. With my parents, I often visited Warsaw, where Roman lived with his family. He also used to come to Wrocław entertaining us all with his with cutting jokes and anecdotes. He had been known for his good humour.

His interjections, comments and remarks were always on an intelligent level, as was his work and scientific creativity.

The uncle's love for tourism and sports, especially skiing, was also well known. My Dad (his brother), also an avid skier, used to take me, even as a small boy, to the mountains and harshly trained to ski. And so there were many occasions to go together to various slopes of our magnificent mountains, most often the Karkonosze, the ski area closest to Wrocław.

Once, as I recall, my uncle organized a trip from Warsaw to Szklarska Poręba taking my father and me, a high-school boy at that time. It was an unusually warm April. We stayed in Szklarska Poręba and Hala Szrenicka was our ski area. Then a funny incident happened. After

many hours of downhill skiing, we decided to return to the town we lived. And here Romek came up with an idea – why go down on foot, we'll ski down through the forest on the side of the ski area. We did it successfully up to the moment when the road was crossed by a rapid stream. Not much thinking, the uncle took off his skis and, lifting his trousers, stepped into the water. My father did the same, and I tried to jump over the rocks with my skis under my arm, which was quite difficult. Romek was already on shore and jokingly commented on our efforts. We put on our skis and slowly continued through the forest. And here suddenly a second branch of the stream crosses our path, even wider and deeper. Uncle continues joking, my Dad growling. Another stream crossing, and Roman falls into a hole, wetting himself to the waist, provoking his brother's comments and laughter. Now the skis on the shoulder and we walked, and again the road was cluttered with water. We saw that the stream splits into parallel branches, and this happened three more times!!! The brothers started making uncensored remarks and at the fifth creek we decide to go along it, because we did not feel like soaking again. And so, after 15. minutes of walking we come to a bridge (!) – a place where the branches descend into one stream!! So, it would have been enough to start walking 200 m along the water and ... I won't quote Professor's comment here. Another hour of walking and we were at our destination. But the Uncle still claimed that he had an ingenious idea.

This is just one anecdote about my dear Uncle Roman, a very affectionate, warm, though sometimes harsh, Mentor and Professor, liked by his staff and loved by his family and myself.

Ryszard Teisseyre

Translated by Anna Dziembowska

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