

Modern Deep Seismic Reflection Investigations in Poland: Fulfilled and Unrealised Ideas of Professor Aleksander Guterch

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The present author has been impressed by the scientific activity of Professor Aleksander Guterch since the early 90s of the last century, when the EUROPROBE Program (1992–2001) has been carried out. Professor was one of the key figures in this fruitful international scientific project. He raised respect for his previous achievements, while his organizational skills contributed much to the scientific output of the program. It was then that the Professor's extraordinary personality trait became apparent: his ability to define key scientific challenges and then his persistence in carrying out research leading to their solution. In this contribution, this unique determination will be presented through an example of a fragment of his scientific activity regarding deep seismic reflection research in Poland.

1. THE PIONEERING POLCRUST-01 PROGRAM

By the end of the first decade of the present century, Prof. Aleksander Guterch, assisted by Prof. Marek Grad (Institute of Geophysics, University of Warsaw), put forward the idea of the first modern seismic reflection profile in Poland, imaging the whole crust down to the Moho boundary. The idea referred to previous similar international projects such as the Canadian LITHOPROBE, German DEKORP or Finnish FIRE. Owing to the Professors' authority and determination, it was possible to organize the Industry–Academia Consortium led by the Institute of Geophysics, PAS, and with participation of Geofizyka Toruń Ltd. and PGNiG S.A. – the Polish Oil and Gas Company. The project, conducted in 2010–2012, was co-funded by the Polish Ministry of Environment through the National Fund for Environmental Protection and Water Management, and Polish Oil and Gas Company PGNiG S.A.

The ca. 240 km long POLCRUST-01 profile runs across SE Poland more or less along the line linking Sanok and Zamość cities (Fig. 1). The geological importance of this area stems from the fact that it covers different, partly weakly recognized deep structures, and that it has been the subject of petroleum exploration for a long time. The profile crosses, from SW, the East Carpathian nappes, the Carpathian Foredeep Basin with its Precambrian basement, Caledonian and Variscan units of the Małopolska and Łysogóry blocks, contacting with the East European Platform (EEP) through the Teisseyre–Tornquist Zone (TTZ). The general pattern of crustal structure of the region has been known since the deep refraction seismic

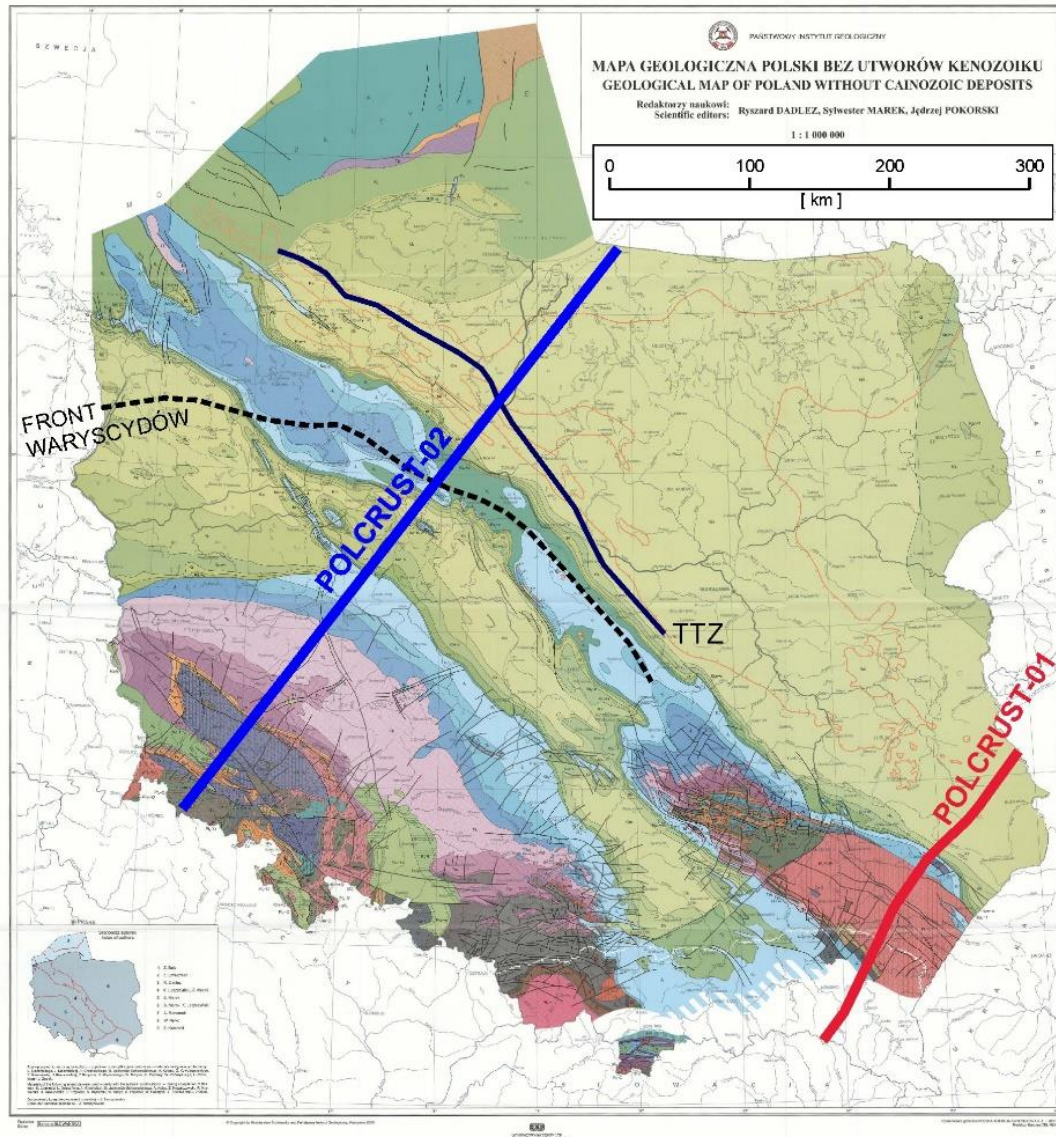


Fig. 1. Location of the POLCRUST-01 and -02 profiles against the map of Poland without a Cenozoic cover (Dadlez et al. 2000). Version attached by Prof. Guterch to materials promoting the POLCRUST-02 program during 2015–2020.

CELEBRATION 2000 Project led by Professor Guterch (e.g., Guterch et al. 2003; Narkiewicz et al. 2011). The relatively small thickness of the post-Paleozoic sediments pierced by numerous boreholes ensures a reliable seismic representation of a basement structure. Because of all these circumstances, the area was optimum for executing the methodologically and organizationally precursory POLCRUST-01 profile.

The seismic data was acquired from August to October 2010 applying the Vibroseis (ca. 4000 shot points) and, to a lesser extent, explosives, with parameters typical for exploration seismology (30 m receiver and 60 m source intervals) and high (175) nominal CDP fold, with an unusually high source effort and long recording time attaining 30 seconds. Such methodology, coupled with the application of novel processing techniques (Malinowski et al. 2013, 2015), resulted in the unprecedented quality of the whole crust imaging. This provided excellent material for the geological interpretation of shallow and deep crustal structure, including the Moho boundary, and made it possible to trace the relationship between superimposed structural patterns of different age.

The confrontation of the data obtained with those from the previous seismic refraction projects shed new light on architecture and deep crustal controls of Paleozoic and Mesozoic basins in the marginal part of the EEP and neighbouring tectonic blocks. The data contributed to a revised model of the Lublin Basin development, including the importance of inherited pre-Devonian tectonic structures. For the first time, the results revealed complexities of the tectonic contact between the craton and main neighbouring units, the Małopolska and Łysogóry blocks in particular. They stressed the importance of near vertical tectonic discontinuities representing repeatedly reactivated fault zones with a strong strike-slip overprint (Narkiewicz et al. 2015).

2. THE IDEA OF THE POLCRUST-02 PROGRAM

Professor Guterch intended that the POLCRUST-01 profile would be only the beginning of the new era of investigations of the deep geology of Poland. The main aims were to study deep tectonic controls on the establishment and development of sedimentary basins and better constraints on hydrocarbon and metal ore exploration targets. The natural consequence of the finished project was thus a planned POLCRUST-02 profile, ca. 500 km long, crossing Poland approximately along the line linking Jelenia Góra–Leszno–Bydgoszcz–Elbląg cities (Fig. 1). The methodology of seismic investigations would generally follow that applied for the POLCRUST-01, making it possible to obtain accurate records including upper sedimentary layer as well as the crystalline crust down to the Moho boundary. Such an approach, successfully tested in the previous project, would enable tracing deep crustal features and their possible influence on depocenters' evolution.

The planned profile runs across the zones of contact of the main geological provinces of Europe: from the EEP separated by the TTZ from the Caledonian accretion belt and crossing the outer and inner (Sudetic) domain of the Variscan Orogen. In the post-Variscan structural pattern, the line crosses the Permian–Mesozoic Polish Basin (part of the Central European Basin System), including hydrocarbon- and metal-bearing Rotliegend and Zechstein strata of the Southern Permian Basin. The profile could thus supply valuable data to solve crucial issues of regional and economic geology, such as:

- the tectonic structure of the Pomeranian sector of the TTZ and depositional architecture of Ediacaran and Lower Palaeozoic basins of the EEP margin;
- sub-Devonian structure of the crust south-west of the TTZ, including the nature of Caledonian structures and possible occurrence of crustal blocks and separating tectonic sutures;
- architecture of the Variscan Orogen, both its deeply buried external part (Wielkopolska Externides) as well as the shallow internal part (Fore-Sudetic Block and the Sudetes – part of the Bohemian Massif);
- localization and characteristics of the buried Variscan Front and the Rheno-Hercynian Suture separating the outer and inner parts of the orogen, respectively; the possible occurrence of Carboniferous coal basins potentially sourcing the gas traps in the Permian reservoirs;
- relationship between the sedimentary fill of the Polish Basin with its hydrocarbon potential and metallogenesis and deep Caledonian–Variscan substrate inaccessible by boreholes; deep controls on Permian–Mesozoic tectonism.

3. EFFORTS TO IMPLEMENT THE NEW PROGRAM

Professor Guterch started his efforts to launch the POLCRUST-02 Program soon after the formal termination of the previous one. The initial plan was to organize a scientific-industrial consortium with a leading role played by, besides the Institute of Geophysics PAS, the PGNiG S.A. and the Polish Geological Survey (PGS) represented by the Polish Geological Institute – National Research Institute (PGI–NRI). From the outset, the management of the upstream sector in the PGNiG had a positive attitude, taking into account the promising results of the

POLCRUST-01 project. Aiming for formal inclusion of the PGS in the new project, Professor arranged a workshop in the Ministry of Environment on September 25, 2013, with the participation of the Main Geologist of the Country (MGC) as well as staff members and director of the PGI–NRI. During the meeting, the project was preliminarily approved by MGC who accepted the PGI–NRI as the participant. As a representative of the government supervising the PGS, he recommended that the director of the PGI–NRI should take formal steps to confirm its accession. Unfortunately, it never happened as the director did not issue an expected document, whereas the dismissal of the MGC from the office in December 2013 stopped further action to organize the program (Narkiewicz 2019).

All these circumstances were at the beginning of a sequence of events, tightly connected with the political, organizational, and personal changes in the institutions involved, which in successive years hindered or even paralysed the efforts of Professor Guterch. In our later conversations, Professor repeatedly returned to the year 2013, stressing his disappointment with the obstruction of the PGI–NRI director in a situation when the decision to launch the POLCRUST-02 Program seemed to be within reach. Nevertheless, with his typical optimism, he did not give up further efforts, tirelessly maintaining contacts with institutions that could participate in the research financially and organizationally.

Being ensured as to the positive intention of the PGNiG, Prof. Guterch made a proposal to participate in the consortium to the management of KGHM Polska Miedź S.A. The main concessions of this giant copper and silver mining and processing company are located in the Sudetes and its foreland – exactly in the area crossed by the planned profile. During the visit to the KGHM headquarters in Lubin (May 10, 2015), the main premises and objectives of the program were presented, stressing its potential significance for metallogenic questions connected with the ores. Key representatives of KGHM expressed their interest in participating in the consortium and promised a positive recommendation to the management and the CEO of the company. Professor Guterch was asked to issue an official letter to the CEO with a proposal to participate.

Consequently, the Professor prepared a project of the letter to be signed by the management of both the Polish Geological Institute–NRI and the Institute of Geophysics PAS. Earlier, on March 16, 2015, the director of the latter institute sent to the PGI–NRI an invitation to participate in the planned scientific-industrial consortium. At Prof. Guterch's request, the present author met with the then-head of the PGI–NRI, but he refused to sign the letter, referring to previously obtained negative opinions. He abstained from presenting the arguments behind such opinions, promising their later disclosure by the authors (which never happened, though). Thus, the management of the PGI–NRI again effectively torpedoed the efforts to launch the POLCRUST-02 Program, without providing any rationale.

The coming years were spent by Prof. Guterch on further arduous efforts, focusing mainly on meetings and discussions with successive incarnations of decision-makers in the planned participating institutions. In each case, Professor was forced to explain *ab ovo* the idea of the program, convincing his more or less competent interlocutors about its scientific and practical significance. He, as always, showed great patience and persistence, never losing hope for a positive outcome of these efforts.

The next and, as it later appeared, the last attempt to initiate the POLCRUST-02 program took place at the turn of 2019 and 2020. At that time, the organizational plan formulated by Prof. Guterch assumed to maintain the earlier methodological assumptions of the project. The scientific-industrial consortium would include the Institute of Geophysics PAS, the Institute of Geophysics of the University of Warsaw, the Ministry of Environment, the PGS, the PGNiG S.A. and, possibly, the KGHM S.A. The schedule would include performing, in 2021–2023,

seismic fieldwork, collection and processing of data and comprehensive geophysical and geological interpretation based on all available regional and detailed materials and using various methodologies, including geological-geophysical modelling.

The key to launching the plan was a positive decision of the then MGC to allocate financial resources to the planned PGS project “Program of deep reflection seismic investigations of the Earth’s crust in the area of central and south-western Poland – POLCRUST-02”. On February 17, 2020, the project was presented by M. Narkiewicz in the Ministry of Environment. It was positively assessed by the MGC (letter from February 22, 2020), but, unfortunately, this did not mean a positive end to the effort. The meeting arranged in the ministry by the MGC in March 2020 revealed the disagreement of the PGI–NRI management represented by the Director of PGS. It also appeared that after repeated changes in organization and management, the PGNiG lost its interest in the program. The arguments put forward by Prof. Guterch, Prof. Grad, and the present author were disregarded, and finally, the project has not been accepted.

It was a strong blow to the plans of Professor Guterch, who did not hide, in private conversations, his disappointment with the short-sighted approach of officials supported by some narrow-minded scientists. Later contact with Professor attested to his ongoing determination and the pursuit of new attempts to revive the idea of the POLCRUST-02 Program. The climate for such attempts in the ministry (which in the meantime changed its label to “Climate and Environment”) was not favorable. The premature death of Marek Grad (May 17, 2020), who supported Professor in his efforts, and the exploding COVID-19 pandemic added to the difficulties in further organizational arrangements...

4. FINAL THOUGHTS

The personality and scientific accomplishments of Prof. Aleksander Guterch left a lasting mark on the deep reflection seismic research in Poland. His unquestionable achievement is the first modern profile POLCRUST-01, which provided a wealth of new data about the deep geological structure of Poland. It laid the foundations for the implementation of similar projects, including the planned POLCRUST-02 transect crossing the entire country – from the Sudetes to the border with Lithuania. Professor devoted a lot of energy to organizing this research and believed in its implementation until the end of his scientific activity. Unfortunately, due to a combination of various circumstances presented here, this supposedly groundbreaking project was not launched. The Professor’s efforts did not have a happy ending during his lifetime, although they will certainly not be without consequences in the future. They are the testament of Prof. Aleksander Guterch to future researchers who, sooner or later, will return to the ideas He outlined.

References

- Dadlez, R., S. Marek, and J. Pokorski (2000), Geological map of Poland without Cainozoic deposits (1:1 000 000), Polish Geological Institute, Warszawa.
- Guterch, A., M. Grad, G.R. Keller, K. Posgay, J. Vozar, A. Špičák, E. Brueckl, Z. Hajnal, H. Thybo, O. Selvi, and CELEBRATION 2000 Experiment Team (2003), CELEBRATION 2000 Seismic Experiment, *Stud. Geophys. Geod.* **47**, 659–669, DOI: 10.1023/A:1024728005301.
- Malinowski, M., A. Guterch, M. Narkiewicz, J. Probulski, A. Maksym, M. Majdański, P. Środa, W. Czuba, E. Gaczyński, M. Grad, T. Janik, L. Jankowski, and A. Adamczyk (2013), Deep seismic reflection profile in Central Europe reveals complex pattern of Paleozoic and Alpine accretion at the East European Craton margin, *Geophys. Res. Lett.* **40**, 15, 3841–3846, DOI: 10.1002/grl.50746.

- Malinowski, M., A. Guterch, M. Narkiewicz, Z. Petecki, T. Janik, P. Środa, A. Maksym, J. Probulski, M. Grad, W. Czuba, E. Gaczyński, M. Majdański, and L. Jankowski (2015), Geophysical constraints on the crustal structure of the East European Platform margin and its foreland based on the POLCRUST-01 deep reflection seismic profile, *Tectonophysics* **653**, 109–126, DOI: 10.1016/j.tecto.2015.03.029.
- Narkiewicz, M. (2019), "Sto lat badań głębokiej budowy geologicznej Polski w Państwowym Instytucie Geologicznym..." – odpowiedź na polemikę, *Prz. Geol.* **67**, 10, 808–811.
- Narkiewicz, M., M. Grad, A. Guterch, and T. Janik (2011), Crustal seismic velocity structure of southern Poland: preserved memory of a pre-Devonian terrane accretion at the East European Platform margin, *Geol. Mag.* **148**, 2, 191–210, DOI: 10.1017/S001675681000049X.
- Narkiewicz, M., A. Maksym, M. Malinowski, M. Grad, A. Guterch, Z. Petecki, J. Probulski, T. Janik, M. Majdański, P. Środa, W. Czuba, E. Gaczyński, and L. Jankowski (2015), Transcurrent nature of the Teisseyre–Tornquist Zone in Central Europe: results of the POLCRUST-01 deep reflection seismic profile, *Int. J. Earth Sci.* **104**, 3, 775–796, DOI: 10.1007/s00531-014-1116-4.

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