

The Ancient Maps of the Salt Mine in Wieliczka

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SUMMARY

A maps especially a historical maps are one of the completest and the most reliable, free of subjective points of view, sources of information about the natural, economical, demographical, cultural, political conditions existing in a given region. The old cartographic materials are of great importance not only to historians but also to people of present economic and technical organizations.

The Wieliczka salt mine maps are the valuable cartographic relics of Poland and may be of the whole Europe. They were done by Marcin German in 1638 sixty years later than the oldest maps of zinc mine in Altenberg in 1574, gold and silver mine in Tarnowskie Góry in 1577 and gold mine in Grakofel near Steinfeld in 1577.

In this paper we first gave a general description of the Marcin German maps: the name of location, the time of preparation, its range, original title and so on. Then the detail maps description are given: e.g. the number of sheets, its state of destruction. In the third part we described: land used, buildings, property, register of the owners, size of the lots, inscription and other elements. The fourth part describes the evaluation map accuracy and the places where the archival data are collected.

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1. INTRODUCTION

For thousands of years salt has played a huge role in the economy, politics and even in religions. Salt was extracted in a number of places in various ways: by evaporation of sea water, water evaporating (natural waters that contain a lot of salt), the mining excavation of salt deposits.

The first statements about the salt you can find in the books of the Old Testament. In ancient times salt has played the role of the way of payment. The Hebrews were the first to have discovered the healing ability of salt, so often accompanied them during religious rites. The Romans discovered the ability of salt maintaining and have used it to prolong the freshness of meat, fish, vegetables, or cheese. In Rome, salt played an important role in the trade. In the form of salt have been paid soldiers wages.

In medieval Europe the role of salt was so appreciated, that were determined the roads in international trade. During this period were so-called "salt roads" that is a routes on which the salt were transported.

The origins of the salt excavation in Wieliczka mine are associated with the using of "salt springs" its means the spontaneous outflow of saltwater in this area. The solution was collected and purifying and then brewing (cooking). The origins of excavation dates back to the era of the middle Neolithic (3 thousand years BC).

Exploitation of saline springs took 3 – 4 millennia, until the ending of natural outflows. Then, at the turn of the 12th and 13th centuries, began to drill down deeper wells. The first pit for extracting rock salt dig out in the near Bochnia town. Soon also Wieliczka has become a place where shallow salt deposits were found. Soon the wells have turned into pits, which are the vertical roads of communication with other horizontal walkways and excavation chambers. So in that way the Wieliczka mine was created.

The Wieliczka Salt Mine (Polish: Kopalnia soli Wieliczka), located in the town of Wieliczka in southern Poland, lies within the Kraków metropolitan area. Opened in the 13th century, the mine produced table salt continuously (Figure 1), as one of the world's oldest salt mines in operation. Throughout, the royal mine was run by the Salt Mines Company called *Żupy Krakowskie*.



Figure 1 Present view of Wieliczka center with the salt pit

Wieliczka salt mine has 9 levels, the first of which is level Bono, down to a depth of 64 meters, while the last is 327 meters below the surface of the Earth. The total length of the walkways that connect about 3000 excavations (sidewalks, ramps, chambers, lakes, wells, pits) exceeds 300 km. Volume of the mine is about 7.5 million m³.

2. BRIEF OVERVIEW OF WIELICZKA SALT MINE MAPS WITHIN THE YEARS 1638-1768

In primitive conditions maps usually are not used. So it was with the salt mine in Wieliczka. After 400 years, the presence of mines surveyor became a indispensable. In the history of the mine we find statement that the first surveyor of the mine was in the 16th century Peter the Frenchman Piestrak (1902). Mine was already then very large industrial company and required a rational economy of bed salt. On the surface appeared the first damages of buildings. In the year 1582 as a result of the collapsed of the chamber Małdrzyk, were damaged at least 25 buildings. In order to prevent further accidents had to be employed a surveyor. This information is also in the inscription on a map of Wieliczka done by Borlach (1743). The inscription says "*Who the salt mine measure..., he must be Surveyor and those work good know.*". Therefore the district administrators tried to have a good surveyors.

Around year 1600 surveying works in the salt mine Wieliczka were performed by the Tabenhey, priest of St. Nicholas Church in Krakow. Between among the famous surveyors, who after Tabenhey worked in Wieliczka it was Jan Brożek (1585 – 1652), a professor at the University of Cracow, performing for several years measuring the Wieliczka and Bochnia mines. He writes about it in a letter dated on 19. IX. 1643 to Stanisław Pułdowski, a professor at the University of Cracow.

Brożek's employed time in Wieliczka is difficult to determine. It had to take place, as is it apparent from the above quote, before the year 1624. Sawicki (1964) state the period for the years 1616 – 1620. So far, unfortunately, it was not found any notes, and especially any mine maps made by Jan Brożek.

In the year 1636 administrator Andrzej Górski brought from Sweden the surveyor who name was Martin German Piestrak, (1901). Looking today for his maps we have no doubt that this was an outstanding specialist in the field of surveying, perhaps even well known in the world. Ruling in the Poland at that time King Władysław IV wanted to have a good surveyor in his mine, famous in Europe¹.

Marcin German upon arrival to Wieliczka, as a foreigner have to lived outside the city walls. He started the very difficult work, what was the measurement all available the easier and more difficult mining excavations. The result of this work were four maps marked with Roman numerals I, II, III, IIII, which until now only three maps exist, and it is map I, III, IIII. Map II was lost during Second World War. The other three maps are stored currently in the Salinian Museum in Wieliczka.

Future maps of the mine in Wieliczka for a number of years were based on measurements and mapping papers done by German, e.g. the map G. Borland from 1718.

Summary of measurements and maps of Wieliczka from the period 1638 – 1768, are listed on one of the old map, includes works by the following authors: M. German 1638, G. Borland 1718, J.F. Müllendorff 1742, J.G. Gebhard 1744, J.G. Schober 1752, J. Stolarski 1762, A. Friedhuber 1768.

The history of the mines listed on the title tab of the current map contains statement of some more historical map done by Lebzelter in 1787, which is in the Salina Museum in Wieliczka.

¹ "this Mine is the richest in Europe. In it one of the largest depth diged by a man "St. Staszic, *O Ziemiordztwie Karpatów*, Warszawa 1815, p. 60.

3. DESCRIPTION OF THE GERMAN MAPS OF SALT MINE IN WIELICZKA

3.1 General description

The name of the Wieliczka salt mine is not given on the maps. Mine is called here by the author as the Magnum Sal. Time of creation of the map is dated year 1638. However, we cannot assume that these maps have been made within one year. About longevity works on the maps shows the inscription which was located on the lost German map marked number II. The inscription was as follows "*Opus non unius anni labere consummatum*"².

Range of map. Area measurement by German corresponds roughly to the present level I of the mine. In the east the west directions mine stretched between the pits Daniłowicz and Lubomierz.

The original title of the map is "*Filum Terminale Adriadae in Labyrintho Carte Quator and Martino Germano Geometra anno 1638 delineatae urbis et Trium Condiuationum Magni Salis Forinarum Ichnographia*"³. "(Piestrak, 1902). This title along with the addition "*Opus non unius anni labore consummatum. Majoribus profuit. Nobis anliundale vindicatum prodest. Posteritatis utilitati de novo consecratum Anno 1743*"⁴ and the initial words in German: "*Copia der Aufschrift jenseitigen*"⁵ was placed by F. Piestrak on the left side at the top of the lost map denoted by II.

The scale and the deformation of the maps. In the development of historical maps to be talking about two different types of scales, the scale of the original, in which the map was made and the deformable scale which is currently. The determination of the present scale of the maps was described in Poczobut-Odlanicki and Milewski (1958). They compared the distances between several pits that are marked on the maps current and on the German maps. It should be noted that in the determination of the distance between the pits on the German maps it was difficult to designate their midpoints, as they are rectangular holes. A comparison of four distances and they averaging gives the denominator value 1:1220. In the work Piestrak (1902) the author states the scale of German maps as 1: 1266 but he does not explain how it was computed.

Units of measurement. On the map I are placed two scales: one in *latr* and one in bars. There is no information concerning distance and area units used on maps.

² "Work made not in one year "

³ "Adriana's thread in the Labyrinth - four sheets of the maps of the city and the three levels of the salt mine done by the surveyor Martin German in the year 1638".

⁴ "the work done not in a single year. Serve the great things. And helps us to enforce the rights. For future use on the newly drawn up in the year 1743".

⁵ "a copy of the title, which is stated on the reverse side".

According to Stamm, (1938) the measurements in the southern Poland from the 14th century to the year 1764 were used units of length known as a *pręt* (*pertica*). *Pręt* was split into 7.5 *łokieć* (elbow) or to 15 *stóp* (feet). The length of the *pręt* given by Stamm, (1938) is 4.395 meter and according to Wierzbowski, (1926) as 4.466 meter.

Cited work Wierzbowski (1926) does not provide further comments on the unit *latr*. There is only an alphabetical list of units mentioned that one *latr* is equivalent to one *sqżeń*.

Author of the maps. On the map I, between these previously mentioned graphical scales is the signature of the artist, namely Martin German Geometra Anno Domini 1638.



Figure 2 Copy of original M. German map I of Wieliczka town done by A. Długosz in 1956. Czaja and Noga (2015)

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3.2 Description of the external maps

Technique. The German maps are plotted on a drawing paper, glued for a maintenance purposes on the canvas. Each map is made of a six separate sheets. Ink (sepia) which was used to draw the maps, is now very faded, so that reading them is very difficult. It is therefore clearly show both later drawing of the mine excavation on the map III and the rectangle grid on a map I.

Number and marks on a sheets. Wieliczka salt mine plan was made by Marcin Germana on four sheets. As previously mentioned, one of the worksheets (II) are lost during the Second World War and only three exist, namely:

- a. map of the earth's surface of Wieliczka mine marked by the roman number I,
- b. map of mine second level marked by a roman number III,
- c. map of mine third level marked by a roman number IIII.

The dimensions of the sheets. Accurate determination of the dimensions of the sheets is very difficult because of their severe damage, and due to the fact that were pasted on the canvas. The dimensions of the current individual sheets are: map I is approximately 126 x 72 cm, the map III is approximately 117 x 62 cm, map IIII is about 124 x 63 cm.

Cover sheets of drawing: map I about 90%, map III about 30%, the map IIII about 20%.

Maintenance status of the maps. All three maps are very damaged. The most damaged is a map marked with the number III, there are lack of its corners that probably have no drawings. It has several serious tears up to 30 cm, and a dozen smaller cracks. Maps formerly had to be folded, hence on each of them are clear traces of the bends. The marks and the descriptions are very blurred, especially on the map I, and so even the use of a good magnifying glass does not enable to read the map content. All the maps contain explanation subtitles made in sepia.

4. CONTENT OF MAPS

4.1 Map I of the earth's surface of the Wieliczka mine

Map (Figure 2) shows the map I. Terrain is not shown on the map. On a map are plotted stream and a few ponds fill with water made probably as a result of the process of the hollows. On a map are shown streets, however without no names, described is only the market.

Marked on map village fields eg. "*Niwa chlebowa Pana Skalskiego*"⁶, gardens and orchards (the symbol of the tree), building plots, the yards, hollows, ponds, sites for the construction of a road or a new shaft.

Selected religious buildings: the Church of St. Spirit, of St. Clemens and St. Sebastian. Industrial buildings or pits: Bonner, Daniłowicz, Górsko, Seraf, Loys, Buzenin, Boża Wola. For industrial objects is included the salt pans and a building Board of Mine.

The objects of urban construction include Wieliczka territory and the walls of the city with the five bastions. Private buildings: mansions for example. "*dwór p. bachmistrza*"⁷ (*Magister Montium*), "regional court", etc., and the houses as "*dom p. Germana Geometry*"⁸, "*dom p. Skalskiego*"⁹. Some of the names of the owners give types of their professions. The largest group of craft are coopers, supplying barrels for mine, further butchers, shoemakers, bakers, and even a bookbinder. On the basis of this maps one can draw some interesting conclusions as to the social and professional groups in Wieliczka.

Buildings are presented by German in perspective, which gives you the ability to faithfully reproduce nature of the urban construction of Wieliczka in the 17th century. Next are given boundaries of the properties and the list of owners and surface plots.

Other map elements. An interesting feature of the map is golden star accompanied by the directions of the world and a description: Mer, Sep, Ori, Occ, which testifies to the carried out magnetic orientation of the map. The direction of the north facing downward figure, so vice versa than we take out.

4.2 The map III, the second level of the mine

This map (Figure 3) it is only image of the situation of the second level and there is lack of any kind of elevation features on it.

Mining excavations presented on the map. Buzenin pit – the only pit coming down to that level. Small pits – Szypowski, Suce etc. Together you can find a dozen of pits.

⁶ "Wheat field of Lord Skalski"

⁷ "the Lord bachmistrz house"

⁸ "house of German Surveyor"

⁹ "Skalski's house"

The Chamber e.g. Skornikowskie, Kielczewskie, Tarnów, Zalesie, etc. A total number of chambers is approximately 50. You must also add that the excavation chambers located below on this plan are marked by dashed lines.

Pits are marked by squares measuring 3 x 3 mm. Small pits are marked by squares measuring 2 x 2 mm. Horse gear are marked by a double cross. The remaining elements, and thus the boundaries of the chambers, walkways, was described as currently only without coloring.

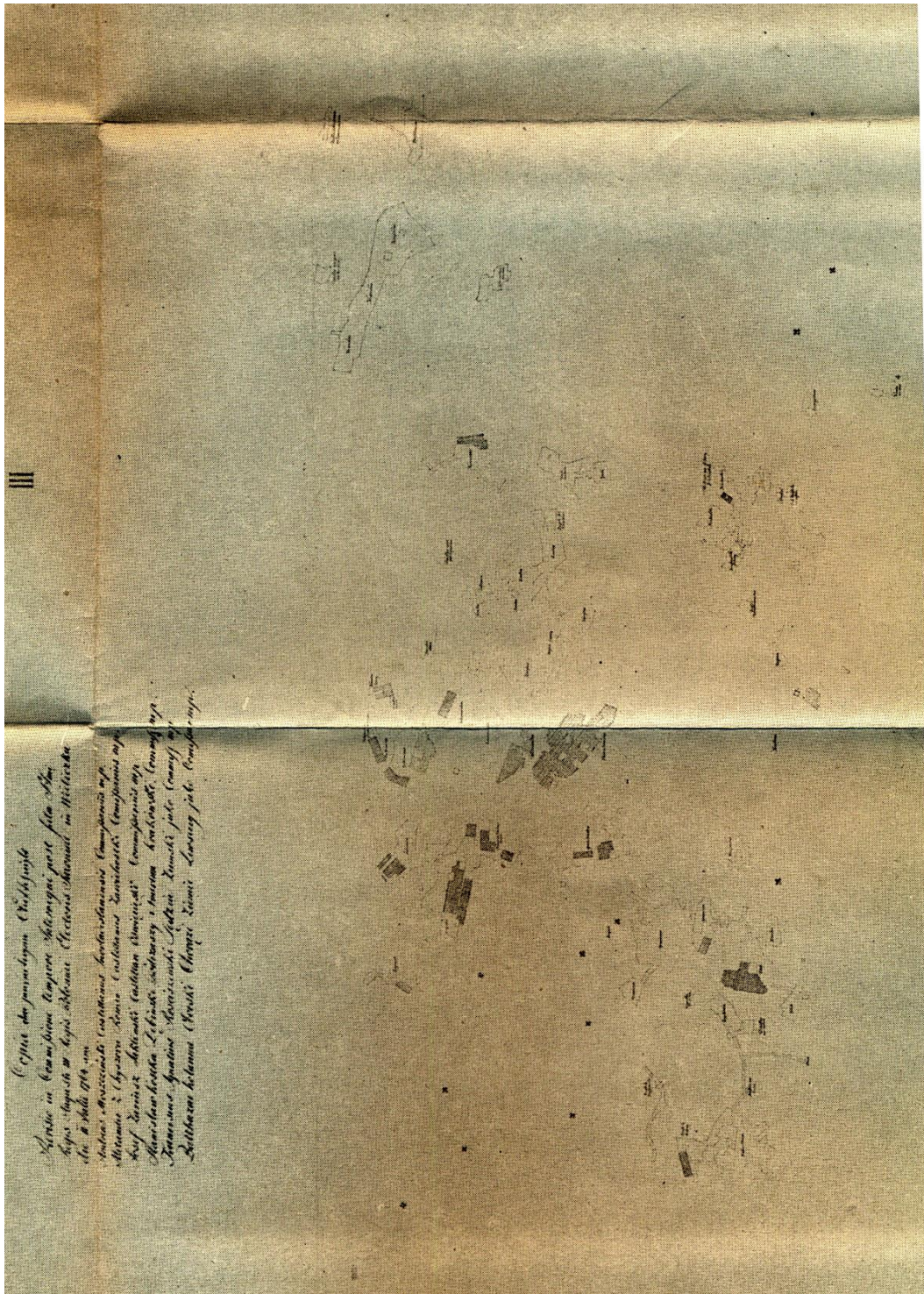


Figure 3 Copy of original map III of salt mine Wieliczka (second level) done by A. Długosz in 1577. Poczubut-Odlanicki and Milewski (1958)

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At the top of the map there is an inscription dating from the year 1764, drawn up by the transfer of mines to the administrator Wojciech from Kluszewo. This inscription on the reverse side of the map, where it was much later rewritten in place, where it is now. The content of the writing is "*Copia der jen seitige Aufschrift Revisio in Commissione tempore Interregni post fata SS-Regis, III, Regis Poloniae, Ellectoro Saxonie in Wieliczka die 11 Juli 1764 anni*"¹⁰ .

4.3 The map III-the third level of the mine

The map (Figure 4) as the previous map it is the plan-were there are no height features. The following mining excavations area are given: pit Lubomierz, small pits for example Władysławski, Lubomierz. In addition to the names of mining excavations plan does not contain any other explanations or captions. The names of the excavations are parallel to the long edge of the paper. Adopted in signs are the same as on the map III.

4.4 Method of measurements and maps construction

Based on the survey publications more or less from this period such as (Solski, 1683), you can most likely assume that measurements of situation both on the surface and at the bottom of the mine were made on the basis of the magnetic traverses, where the characteristic points on the surface were projected on these simple traverses using right angle prism.

An attempt to assess the accuracy of the German maps was carried out in Poczobut-Odlanicki and Milewski (1958). To do this, authors compare the distances between the pits on the basis of modern measurements with the distances between these pits given on German maps based on the *latr* scale. The differences between these distances range from 0.5 to 1%. This value can be taken as an indicator of the accuracy of measurements and drawing up maps at that old times . This ratio is very high for, as the state of the art of surveying in XVI century.

¹⁰ "copy of the title, which is stated on the reverse side. Audio consignment in Wieliczka on 11 July 1764 during the interregnum after the death of Augustus III, King of Poland, elector of Saxony ".

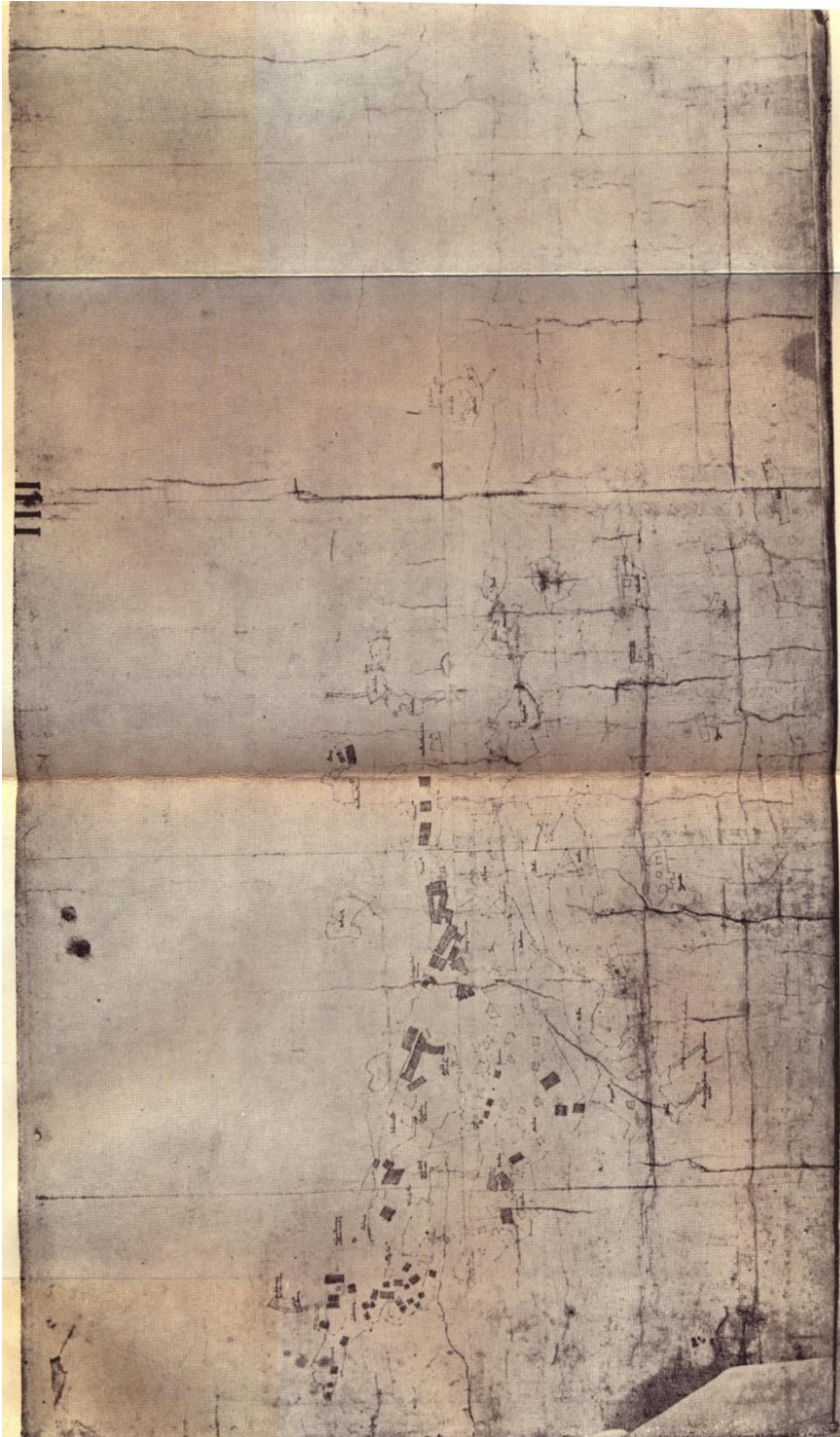


Figure 4 The map IIII of salt mine Wieliczka (third level) done by M. German in 1638. Odlanicki-Poczobut and Milewski (1958)

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BIOGRAPHICAL NOTES

Education and previous appointments:

1967 - Master of Science (M.Sc.), 1975 - doctor (Ph.D.), 1994 - habilitation, 1999, professor.

1967-1968, assistant, *Institute of Geodesy and Cartography* in Warsaw. 1968 -1982, assistant and lecturer, Faculty of Geodesy, *Agricultural and Technical Academy* in Olsztyn (to 1972 Agricultural College). 1982-1984, senior assistant, Organization for Surveying and Cartography "*Geokart*", Warsaw, Poland. 1984-1986, lecturer, *University of Zambia* in Lusaka. 1993, senior lecturer, *University of the West Indies*, Trinidad and Tobago. 1986-2001, professor, *Space Research Center* in Warsaw, 2001-2015, professor, *University of Warmia and Mazury* in Olsztyn.

Interest: Geodesy, gravity field, geodetic networks, surveying.

Selected publications: Łyszkowicz A.,1993, *The Geoid for the Area of Poland*, Artificial Satellites, vol. 28, No 2, Planetary Geodesy, No 19, pp. 75-150, Łyszkowicz A., Denker H.,1994, *Computation of Gravimetric Geoid for Poland Using FFT*, Artificial Satellites, Planetary Geodesy No 21, str.1-11, Łyszkowicz A., Forsberg R., 1995, *Gravimetric Geoid for Poland Area Using Spherical FFT*, IAG Bulletin d'Information N.77, IGES Buletin N.4, Special Issue, Milano, pp.153-161, Łyszkowicz A. Biryło M., Becek K., 2014, *A new geoid for Brunei Darussalam by the collocation method*, Geodesy and Cartography, Vol. 63, No 2, pp. 183-198, Łyszkowicz A., Bernatowicz A., 2017, *Current state of art of satellite altimetry*, Geodesy and Cartography, Vol. 66, No 2,

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