



Soil Science Society of Poland (Wrocław branch)
Czech Soil Science Society
Polish Humic Substances Society
Institute of Soil Science Plant Nutrition and Environmental Protection
Wrocław University of Environmental and Life Sciences

International Symposium and Field Workshop
**Black Earths - origin, transformations, classification
and ecosystem functions**
in relation to
Black Earth – Soil of the Year 2026 (Poland)



Book of abstracts
Field guide

Wrocław - Karczyce
September 2-4, 2026

Field Guide preparation

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Program

Wednesday, September 02, 2026

Arrival to Wrocław or directly to Karczyce (workshop venue)

13:00-14:00 Registration and lunch

14:00-16:00 Oral session 1

- C. Kabala "Black earth – concepts of origin, classification and challenges"
- M. Kozłowski "Elements of black earths' water regime in the western part of the Wielkopolska Lakeland"
- Ł. Uzarowicz, D. Murach, K. Feluch "Development of Bw horizon in black earths following groundwater table decrease"
- B. Strouhalová "Isotopic signatures of Neolithic soils and pit fills shed light on land use and waste management in the Linear Pottery culture"

16:00-16:20 Coffee break

16:20-17:20 Oral session 2

- M. Świtoniak "Diversity of black earths in Kuyavia region"
- B. Łabaz "Fertility status of Chernozems and Phaeozems under different moisture regimes in southwestern Poland"

17:20-18:45 Poster session

19:00-21:00 Dinner

Thursday, September 03, 2026

07:30-08:30 Breakfast

08:30-12:00 Field workshop 1: arable Black Earths

12:00-13:00 Lunch break (in the field)

13:00-17:00 Field workshop 2: arable Black Earths

18:00-19:00 Poster session (continued) and discussion meeting

19:00-22:00 Grill dinner

Friday, September 04, 2026

07:30-08:00 Breakfast

08:00-12:00 Field workshop 3: forest Black Earths

12:00-13:00 Closing remarks, lunch and departure

Abstracts of the presentations and posters

(alphabetically by name of the first author)

BLACKS EARTHS OF DUBIENKA DEPRESSION AND CHEŁM HILLS IN THE STATE FORESTS OF LUBLIN REGION (SE POLAND)

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The spatial distribution of black earths (BEs) located in the forests of the Regional Directorate of State Forests (RDSF) in Lublin, south-eastern Poland, was analysed based on spatial data retrieved from the State Forests of Poland, the Head Office of Geodesy and Cartography of Poland and the General Directorate for Environmental Protection of Poland. Black earths cover 0.75% of area (3,070.40 ha) within the mapped forest site types of the Lublin RDSF. Of this area, 42.23% is located in two neighbouring mesoregions of Volhyn Polesie: the Dubienka Depression and the Chełm Hills. Within these regions, 202 black earth sites cover 1,296.39 ha, comprising 48.23% postmurshic, 39.78% ordinary, 8.56% leached, and 3.44% cambic BEs. These two mesoregions are characterised by extensive areas of nature conservation, encompassing over 90% of all the studied black earth sites. Black earths can be found in the Chełm and Strzelce Landscape Parks, the Chełm Landscape Conservation Area, ecological sites, Natura 2000 sites, and nature reserves. In terms of parent material, glacial deposits predominate (88.75% of the BE area), including 20.66% of the BE area occupied by glacial deposits overlying Cretaceous formations. Marsh, alluvial and lacustrine deposits account for a further 9.31%. The studied BEs have texture of loam (31.29% of BE area), sand (23.19%), silt (11.20%) and sand on loam (10.01%), and 24.22% have a murshic layer. Black earth sites range in size from 0.1 to 70 ha, with areas of 1–10 ha accounting for 54.96%, 0.1–1 ha for 26.75%, and 10–70 ha for 18.33%. In the BE areas, moist broadleaved forests dominate (89.90%), with alder-ash forests accounting for 3.31%. Alder dominates the tree stand (45.04% of trees), alongside oaks (20.28%), birches (15.06%), Scots pine (9.13%), European hornbeam (3.99%), European ash (2.05%) and aspen (1.41%), which together account for almost 97% of the current tree stand. A statistical analysis of the collected data revealed both common and specific features of the four BE subtypes defined in the Classification of Forest Soils in Poland (2000). The following factors were considered: the size and number of BE areas; the nature of the parent geological formations; soil texture; the species composition of the tree stand; the forest site type within the BE areas and their surroundings; and the soil subtypes in the vicinity of the BE areas. The specific natural conditions favouring the occurrence of black earths within the studied mesoregions were identified.

URBAN SOIL HEALTH INDICATORS: A PRELIMINARY ASSESSMENT OF ANTHROPOGENIC PRESSURE AND HEAVY METAL ACCUMULATION IN WROCŁAW

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Rapid urbanization, infrastructure development, and historical industrial activities have significantly impacted urban soil health, leading to increased anthropogenic pressure and the accumulation of heavy metals such as Cd, Pb, Ni, Cu, Zn, and Hg. To address these environmental challenges, a comprehensive student-led research initiative is currently being conducted by the Soil Science and Environmental Protection Student Science Group at the Wrocław University of Environmental and Life Sciences. The broader scope of the project aims to evaluate the extent of soil degradation in Wrocław and explore the potential of urban green waste compost in mitigating heavy metal toxicity.

This preliminary study highlights the initial phase of our collaborative fieldwork and laboratory activities involving students. Currently, 30 soil samples have been successfully collected from locations identified as being under severe anthropogenic pressure across Wrocław. This results will showcase the preliminary findings of our research, specifically focusing on:

- detailed environmental site descriptions to contextualize the anthropogenic impact,
- results of the organoleptic assessment of the 30 collected soil samples, and
- quantitative analysis of total heavy metal concentrations determined via X-ray fluorescence (XRF) spectrometry.

These initial results will serve as a foundational dataset for identifying the most degraded areas in the city and will guide the subsequent experimental phases of the project.

This project is funded by the Wrocław Academic Centre (WCA) within the Student Activity Fund (FAST / Fundusz Aktywności Studenckiej) – 2026 edition.

PROPERTIES AND CLASSIFICATION OF SOILS WITH MEADOW LIMESTONE (KRAKÓW - PYCHOWICE)

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Soils containing lacustrine chalk are characterized by a distinctive morphology and unique physicochemical properties. Their profiles typically include a carbonate-rich lacustrine sediment layer, which is frequently overlain by organic horizons. Key issues associated with soils containing limnic deposits include difficulties in determining their taxonomic position due to their specific morphology, as well as assessing the influence of lacustrine sediments on soil physical and chemical properties.

The aim of this study was to determine the properties and taxonomic classification of soils containing lacustrine chalk. In addition, the susceptibility to degradation of soils developed from different lacustrine and alluvial deposits occurring within the study area was compared. The research was conducted in the Kraków-Pychowice region. Field investigations included the description of six soil profiles and the collection of samples for a range of laboratory analyses, with particular emphasis on surface horizons, soil organic matter characteristics, and micromorphological features.

The studied soil profiles exhibit considerable morphological variability within a relatively small area, making their taxonomic classification challenging. The carbonate sediment has a pronounced effect on several soil properties, including the composition of the sorption complex, carbonate content, and soil reaction (pH). In contrast, the characteristics of soil organic matter appear to be influenced more strongly by other factors, such as vegetation cover and land-use practices. Furthermore, soils developed on more permeable parent materials, such as fluvioglacial sands, show a higher degree of transformation and degradation than soils formed on lacustrine chalk. These findings highlight the importance of lacustrine carbonate deposits in soil development and classification, as well as their role in determining the resistance of soils to degradation processes.

OCCURRENCE OF SEMIMURSHIC BLACK EARTHS AMONG SHALLOW ARABLE ORGANIC SOILS IN SOUTH-WESTERN POLAND

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Black earths are classified as soils of great environmental importance, which is manifested in many aspects. One of the most important at the moment is the binding of significant amounts of organic matter and carbon by these soils, which makes them an important element in the context of climate change. It is also worth emphasizing the very important role of these soils in the retention of fresh water, which in turn is extremely important in the conditions of Poland, or their enormous impact on supporting biodiversity. In a systematic approach, black soils, due to their genesis and properties, differentiate into many taxa (Łabaz B., Kabala C., 2014). One of them are semimurshic black earths (Gleyic Phaeozems (Nechic) - WRB classification (IUSS Working Group WRB, 2015), which according to the Polish Soils Classification 6th edition (SGP6) (Systematyka gleb Polski, 2019), are characterized by an increased presence of organic matter in the accumulation level that meets the criteria for the mollik horizon, which additionally has a murshic or semimurshic character. The soils of this taxon support all the environmental functions attributed to black earths, but due to conditions resulting from their origin, they are characterized by slightly lower values in the context of their agricultural use.

Particular attention was paid to semimurshic black earths during the implementation of a research project aimed at validating the degree of disappearance of shallow organic soils occurring in the north-western region of the Lower Silesian Voivodeship, which is an administrative unit in south-western Poland. In the research, on the basis of agricultural map developed in the 1970s for the entire area of Poland, 500 representative areas of occurrence of shallow (up to 50 cm) organic soils classified according to SGP6 as Murshic soils or Peat soils (according to the WRB Murshic Histosols and Histic Gleysols) and currently used for agriculture in the form of agricultural land or meadows or pastures were selected. The soils present on each surface were verified against the criteria for their qualification as organic soils, i.e. an organic level depth of at least 30 cm and a carbon content of at least 12%. As a result of the work carried out, results were obtained indicating that the vast majority of soils covered by the research (> 97.5%) are currently not eligible for organic soils. Almost 60% of these soils are mineral soils (< 3% C org.), 35% are organic-mineral soils (6-12% C org.), and the remaining 2.5% are mineral-organic soils (3-6% C org.). The main cause of the disappearance of shallow organic soils is considered to be their erosion in the case of murshic soils, and in relation to peat soils, their mineralization as a result of drainage caused by drainage and subsequent erosion of

mineralized organic matter. The indicated processes leading to the degradation of the soils in question are often strongly intensified by anthropogenic activities related to their improper agricultural use and/or impacts related to the presence of copper ore mining in this area.

Among the soils identified and described during the fieldwork, the part constituting 12 % was characterized by the presence of a mollik horizon with murshic or semimurshic character, with a thickness of at least 30 cm and a content of C org. in the range of 6-12%. This level was found in mineral formations with a content of clay fractions above 15 %. With a very high probability, according to the criteria set out in SGP6, such soils could be classified as semimurshic black earths. Bearing in mind the important environmental role of these soils, as well as the significant risk of their disappearance, it seems important to undertake research strictly aimed at recognizing their occurrence in the soil cover and characterizing their physical and chemical properties in detail.

References

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DRAINAGE-INDUCED SOIL TRANSFORMATION IN A FEN PEATLAND OF CENTRAL POLAND: IMPLICATIONS FOR REWETTING AND SUSTAINABLE MANAGEMENT

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Paludiculture, which relies on rewetting drained peatlands, represents a promising approach for peatland conservation and sustainable management, by maintaining high groundwater levels, limiting peat decomposition, and reducing carbon emissions. This study evaluates the viability of paludiculture management on a fen peatland in the temperate climatic zone. The investigated peatland has been affected by agricultural drainage and a brief period of peat extraction in the 1990s. Field surveys and soil sample collection were conducted in September 2023, followed by soil morphology and physico-chemical analyses to classify the soils and assess their hydrophobicity, organic matter content, and secondary transformation. Prolonged drainage significantly altered soil properties, leading to the transition from Histosols to Gleysols. Soil profiles exhibited varying degrees of hydrophobicity, with MED values ranging from 5.0 to 8.5, indicating slight to moderate hydrophobicity. The highest degree of secondary transformation (W_1 index of 0.92) was observed in profile 4. However, profiles 1–3 showed strong potential for paludiculture due to their peat decomposition and hydrological conditions. Paludiculture implementation is expected to support sustainable agriculture, while conservation tillage or grassland management is recommended in areas with advanced secondary transformation to prevent further organic matter depletion in the surface horizons.

Keywords: grassland; drainage; soil transformation; fen peatlands; wet agriculture

BLACK EARTHS – CONCEPTS OF ORIGIN, CLASSIFICATION AND CURRENT THREATS

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The Soil Science Society of Poland has elected black earth (czarna ziemia) as Soil of the Year 2026 in Poland. This specific term refers in Polish tradition to soils similar to Chernozems, but wet. Essential for black earths is a thick, rich in humus and biologically active mollic horizon, that commonly meets the criteria for chernic, accompanied by gleyic or stagnic properties present in the subsoil. According to WRB, Black Earths may belong to at least five reference soil groups. The most typical, drained black earths belong to Gleyic/Stagnic Phaeozems or even to Gleyic/Stagnic Chernozems, if calcic horizon/protocalcic properties persisted the Holocene leaching. Water-logged black earths belong to Mollic/Chernic Gleysols or, rarely, to Mollic Stagnosols. Moreover, black earths having (Miocene) clays in a shallow subsoil can meet criteria for Mollic Planosols. In the past, also the clayey black earths, presently classified as Vertisols, were involved. In terms of the Soil Taxonomy, majority of Black Earths are in Aquolls. Most of Polish black earths meet the criteria of the black soils of the 'Category 2' by FAO Global Soil Partnership, as their CEC typically is lower than 25 cmol(+)/kg required for black soils of 'Category 1'. At least five-six scenarios of genesis have been derived for black earths, but most of them assumes significant human impact. Many black earths are considered relict or polygenetic soils. Black Earths typically have loamy or silty-loamy textures as they develop of loess, glacial and colluvial loams, less commonly on sands and clays. Black Earths have high base saturation throughout their profiles and may contain secondary carbonates in the subsoil, while agricultural lime in the topsoil. Black Earths occur in flat or concave landforms with high groundwater level or seasonal stagnating surface water. Without artificial drainage, Black Earths serve as productive meadows or pastures, but are too moist for cereals. However, after drainage, their productivity is comparable with those of Chernozems; therefore, drained Black Earths are among the best cropland soils in Poland, suitable for wheat, barley, corn, and sugar beet. In case of early summer droughts, recently increasingly common due to climate change, the presence of water in their subsoil may even result in higher stability of yields compared to well-drained Chernozems. Unfortunately, long-term and intense drainage may result in a decrease of organic carbon pools. Moreover, many black earths located near large cities are dramatically threatened by urbanization. Black earths occur in many countries of the northern hemisphere and everywhere are considered among the most valuable soil resources, but everywhere generate similar scientific question and are exposed to similar threats.

SOIL ORGANIC CARBON, HUMIC SUBSTANCES AND CLAY MINERAL COMPOSITION IN CULTIVATED VERTISOLS

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Soil organic matter (SOM) is a key component that plays a crucial role in controlling soil fertility and the physicochemical properties of agricultural soils. Vertisols have considerable potential for SOC stabilization due to the predominance of smectite in the clay fraction. However, the content, fractionation, and characteristics of SOM in cultivated Vertisols remain insufficiently understood. The aim of this study was to assess soil organic carbon (SOC) content and stocks, characterize humic substances, and determine the clay mineral composition of the plough (Ap) and subsurface (AB) horizons of cultivated Vertisols. Selected soil properties, including particle-size distribution, bulk density, pH, cation exchange capacity, SOC, humic- and fulvic-acid carbon (C_{HA} and C_{FA}), dissolved organic carbon and nitrogen (DOC and DON), clay mineral composition, and easily extractable glomalin-related soil proteins (EE-GRSP), were determined. Glomalin may contribute to SOC stabilization by promoting aggregate formation and enhancing the physical protection of organic matter. Humic acids were characterized using UV–Vis spectrophotometry, whereas the mineralogical composition of the clay fraction ($<2.0\ \mu\text{m}$) was determined by X-ray diffraction (XRD). The Ap and AB horizons had clay loam, clay, or silty clay textures, with smectite identified as the dominant mineral in the clay fraction. The long-term conventional ploughing system was associated with increased bulk density in the subsurface horizons. Soil organic carbon content ranged from 18.2 to $22.2\ \text{g kg}^{-1}$ in the Ap horizon and from 9.43 to $15.3\ \text{g kg}^{-1}$ in the AB horizon. Mean SOC stocks were significantly higher in the Ap horizon ($8.32\ \text{kg m}^{-2}$) than in the AB horizon ($3.42\ \text{kg m}^{-2}$). Although SOC content decreased with depth, the C_{HA}/C_{FA} ratio was significantly higher in the AB horizon, suggesting a greater relative contribution of humic acids and a higher degree of humification. Conversely, the higher E4/E6 ratio in the Ap horizon indicated a greater contribution of less-condensed humic structures. The predominance of smectite may contribute to SOC stabilization through organo-mineral interactions and may influence the physical protection of organic matter through its effects on soil structure and shrink–swell dynamics. Overall, the results indicate that the smectite-rich mineralogy of cultivated Vertisols may favor the retention and stabilization of organic carbon, highlighting the potential importance of these soils as reservoirs of organic carbon in agricultural landscapes. A better understanding of SOC stabilization in clay-rich agricultural soils may contribute to the development of sustainable soil management strategies under changing climatic conditions.

FERTILITY STATUS OF BLACK SOILS (CHERNOZEMS AND PHAEOZEMS) UNDER DIFFERENT MOISTURE REGIMES IN SOUTHWESTERN POLAND

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Black soils (SgP, 2019), commonly classified as Chernozems and Phaeozems according to the WRB (2022), are considered as the most fertile soils in the world. In Poland, they are of particular interest due to their limited contribution to soil cover, which does not exceed 1.5%. The study focused on the characterization and regional and global comparison of SOC and fertility status of black soils order (SgP, 2019) in SW Poland, represented by three types: chernozems, black earths and chernozemic colluvial soils in order to provide arguments for their further protection. The soils developed from loess were cross-analyzed in relation to their classification (Chernozems versus Phaeozems) and moisture status (well-drained versus imperfectly-drained soils). The soils have a silt loam texture and a greater thickness of humus horizon, pH, base saturation, content of SOC, nitrogen, and plant-available P, K and Mg than majority soils in Poland. The mean values were comparable or higher than in the other chernozemic regions in Poland and the world; only pH and SOC were lower than in Chernozems of the steppe zones. On a regional scale, Chernozems had a higher pH, base saturation, SOC, P and K concentrations and pools than Phaeozems. Whereas, the moisture status did not significantly differentiate the fertility of chernozemic soils, which confirms that long-term moisture control of historically waterlogged soils allowed for their cultivation with the same intensity as well-drained soils. Comparison with historical data suggested that SOC and nutrients increased or remained at a similar level over the 70 years. The study confirmed a high and stable SOC and fertility status of chernozemic soils in SW Poland, maintained rather than degraded by agricultural use. Considering an ongoing climate change, leading to increasing frequency of droughts in Central Europe, as well as rapid urbanization, resulting in destruction of native soils, the results argue for permanent monitoring and legal protection of Chernozems and Phaeozems as soils of great importance for national food security and SOC sequestration.

EVALUATING THE IMPACT OF MOISTURE REGIMES ON THE SOIL QUALITY AND NUTRIENT POOLS OF WROCŁAW BLACK EARTHS IN THE SILESIA LOWLAND (SW POLAND)

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Chernozems and Phaeozems in southwestern Poland, locally designated as Wrocław black earths, represent a relict soil resource characterized by exceptional pedological value and agricultural productivity. Developed from various parent materials, including loess covers they exhibit deep humus horizons exceeding 50 cm, high values of soil organic carbon (SOC), total nitrogen, base saturation, and plant-available macronutrients (P, K, and Mg). The mean values of their physicochemical properties are higher or comparable to those reported from other chernozemic regions globally, although topsoil pH and SOC pools remain lower than those observed in continental steppe Chernozems. At the regional scale, taxonomic differentiation according to the WRB (2022) demonstrates that Chernozems possess significantly higher topsoil CaCO₃ concentrations, pH, base saturation, as well as higher SOC, P, and K concentrations and pools compared to Phaeozems. In contrast, the moisture regime (well-drained versus imperfectly drained) does not significantly differentiate soils with respect to their fertility parameters or macronutrient abundance. This absence of statistical differentiation suggests that the long-term artificial drainage and hydrological management of historically waterlogged sites has effectively facilitated agricultural cultivation and fertilization at levels comparable to those observed in naturally well-drained soils. Nevertheless, high data variance revealed localized negligence in liming and fertilization, alongside varying cultivation intensities.

Historical comparisons spanning a period of seven decades indicate that SOC pools and nutrient levels have remained stable or increased under continuous agricultural utilization. Wrocław black earths, settled and cultivated since the Neolithic period, maintain a high and stable SOC and fertility status beneficial for crop production on both national and global scales, which has been preserved rather than degraded by long-term agricultural use. Our findings emphasize the necessity for the wise management and protection of Chernozems and Phaeozems in Poland as soils of critical importance for national food security that retain significant potential for SOC sequestration under conservation agriculture.

AEOLIAN SILT DEPOSITION OR IN SITU WEATHERING OF ROCKS? VERIFICATION OF THE PARENT MATERIAL OF SOILS IN OPAWSKIE MOUNTAINS (SW POLAND)

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Parent material directly influences soil-forming processes. The weathering of bedrock has long been considered the only, and most crucial, source of material for soil formation in mountainous areas (Kroyan, 2017). However, in recent years, attention has been paid to the impact of aeolian silt in mountainous soils (Waroszewski et al., 2019). Therefore, in presented research we evaluate the aeolian contribution to the mountainous soils in the vicinity of thick loess cover. Fieldwork was conducted on two transects in the slope catena on quartzitic and greywacke bedrock. The soils in the studied area were classified as Cambisols, Luvisols and Stagnosols and were characterised by a high content of Hf and Zr which indicated an aeolian silt admixture. Furthermore, three layers were distinguished, which show different inputs of aeolian silt: (1) aeolian mantle, (2) a mixed zone in which loess was incorporated into the local material, and (3) a basal zone, free of the influence of aeolian silt. Obtained results enabled to propose, a hypothetical pathway for soil formation in mountainous areas influenced by aeolian silt admixing (Loba et al., 2020).

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SOILS AS RECORDS OF PAST HUMAN ACTIVITY ON LEDNICZKA ISLAND

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In 2021–2022, archaeological investigations were carried out on Ledniczka, the second-largest island of Lake Lednica (Gniezno Lakeland, west-central Poland). The findings confirmed that the late medieval stronghold was established on a natural elevation in the southern part of the island, which was transformed into an approximately quadrangular mound through excavation and redeposition of local material (Pawlak 2024). Recent research has also revealed an earlier phase of human activity dating to the 9th and early 10th centuries, as well as a later phase associated with a stronghold functioning from the second half of the 13th century to the first quarter of the 14th century, thus revising the previously assumed chronology of the site. Excavations conducted in 2022 on the northern slope of the rampart revealed two distinct soils representing different stages of landscape development. The buried soil, developed from loamy sands and sandy loams forming the original surface of the island, was classified as calcic black earth (calcareous) according to the Polish Soil Classification (SGP 6) and as Calcaric Calcic Mollic Gleysol (Humic) according to the World Reference Base for Soil Resources (2022). The overlying soil, developed within the anthropogenic embankment constructed from local loams and sandy loams, was classified as humic aggerosol (calcareous) and Cambic Kastanozem (Loamic), respectively. In both soils, intensive redistribution of calcium carbonate, involving leaching, translocation and secondary precipitation, has resulted in the development of calcic horizons. Geochemical analyses revealed pronounced phosphorus enrichment in the buried Ahb and Ab horizons, with concentrations reaching 2438 mg kg⁻¹, approximately three to five times higher than those measured in the surrounding surface soils and in soils developed within the embankment. Such phosphorus enrichment is consistent with substantial anthropogenic influence on the original land surface. In contrast, enrichment factors (EF) calculated for selected metals showed a less distinct anthropogenic signal.

The geochemical evidence, considered together with numerous artefacts dated to the 9th–14th centuries and the discovery of a bridge whose timbers were dendrochronologically dated to AD 913/914 and 914/915 (Pawlak 2024), indicates substantial human presence and activity on Ledniczka well before the construction and functioning of the late medieval stronghold. The buried soil thus preserves a pedological and geochemical record of earlier human occupation subsequently sealed beneath the anthropogenic embankment. Moreover, the independently constrained chronology of the embankment provides a valuable temporal framework for assessing the timescale of pedogenic transformations, particularly those associated with the development of mollic and calcic horizons in an anthropogenically modified archaeological landscape.

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THE DISTRIBUTION OF BLACK EARTHS IN THE LUBLIN VOIVODESHIP

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Black earths were formed from mineral structures rich in organic matter. They were formed primarily under the long-term influence of high groundwater levels in flat depressions where wetland periodically existed in the past. In addition, these soils developed in former lake areas, old alluvial deposits, and the edges of peatlands. Black earths were formed under the influence of grassland and wetland vegetation (Woch 2015).

Based on the soil map at a scale of 1:100 000, it can be concluded that black earths cover 5.23% of the Lublin Voivodeship. Their total area is 1314.1 square kilometers. They are found in the northern, eastern, and southern parts of the province. The largest concentration of the black earths in the Lublin Voivodeship is located in the northeastern part of the province in the Western Polesie region, between Parczew and Terespol. They are formed mainly from sands (weakly loamy sands and slightly loamy sands) and silts. Nearly two-thirds of the black earths found in the Lublin Voivodeship are used as pasturelands and grasslands.

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BLACK EARTHS IN THE CZECH REPUBLIC (MORAVIA) – NATIONAL AND INTERNATIONAL CLASSIFICATION

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Black earths, Czech classification Chernozem, are considered the most fertile soils in the Czech Republic, where they constitute approximately 11% of the total agricultural land with the highest concentration in South Moravia. According to the Czech classification taxonomic system of soils, Chernozem is classified into the reference group of Chernosols, which are defined by the occurrence of a deep humus profile (0.4–0.6 m) together with a *chernic* horizon (deep >0.3m, Munsell YR<3.5 wet, saturation of the sorption complex >60%, HA:FA >1.5), develop on carbonate sediments (loess, sandy loess, marl) (ÚVT and BENTA, 2004). This contribution, based on 5 soil profiles (locations Blažovice, Letonice, Nosislav, Polkovice, Suchohrdly), shows the variability of Chernozem in the region of South Moravia. Most of the described soil pits showed limit values (0.30–0.33m) of the *chernic* horizon. Only at Polkovice site did this horizon to the depth of 0.85m. In the case of the Nosislav soil profile, the color condition was not met. Nevertheless, the soil was classified among Chernozem with respect to its history and parent material. If we compare soil profiles with the WRB classification and its conditions for classifying soil profiles into the reference soil group Chernozems (where Chernozem from the Czech Republic should belong), part of soil pits do not meet the individual diagnostic criteria for the *chernic* horizon. In our case, among the Chernozems in the sense of WRB we can include the areas of Blažovice (Haplic Chernozem Loamic, Aric), Letonice (Haplic Chernozem Clayic, Aric), Polkovice (Haplic Chernozem Loamic) and Suchohrdly (Haplic Chernozem Siltic, Aric). The Nosislav area would be classified as Haplic Kastanozem Loamic according to WRB classification. A recent nationwide correlation assigned only 43% of Czech Chernozem profiles to WRB Chernozems; the remainder included Phaeozems, Kastanozems, Luvisols, Regosols and Calcisols (Rojas et al. 2025).

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USE OF SPECTRAL INDICES FOR THE IDENTIFICATION OF SOILS RICH IN ORGANIC MATTER

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Poland possesses excellent soil cartographic materials at various scales; however, their updating is necessary, particularly with regard to the current distribution and characteristics of soils rich in organic matter. The study was conducted in 2021 in the south-western part of the Northern Masovia Lowland, where one rural municipality was selected and 151 soil contours historically classified as organic soils were identified. A total of 303 soil profiles were described in the field to verify their present soil type and land use and to collect samples for laboratory analyses.

The present study evaluates the potential and limitations of Sentinel-2 spectral indices for identifying soils rich in organic matter. Six indices were analysed: NDVI, NDMI, NDSI, BSI, CI, and BI. Cloud- and cloud-shadow-affected pixels were excluded using the Scene Classification Layer (SCL). $NDVI < 0.30$ and $BSI > 0$ were applied to identify areas with absent or sparse vegetation and potentially exposed soil surfaces.

Sentinel-2 images from August, September, and October were analysed. The applied criteria identified only 33 profiles in August, 42 in September, and 47 in October out of 303 field profiles, indicating that the usefulness of spectral indices is strongly dependent on acquisition date and surface conditions. Particular attention was given to CI and BI as indicators of soil colour and brightness, and to NDMI as an indicator of moisture conditions. The spectral indices were compared with field observations and laboratory measurements, including soil type and organic carbon content, to assess their usefulness for identifying dark, organic matter-rich soils.

Acknowledgements

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ISOTOPIC SIGNATURES OF NEOLITHIC SOILS AND PIT FILLS SHED LIGHT ON LAND USE AND WASTE MANAGEMENT IN THE LINEAR POTTERY CULTURE

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Agricultural practices in Neolithic Europe adapted to distinct local environmental and cultural-chronological settings moderated by the distance from the settlement, which suggests a large variability of farming systems (e.g., Bogaard 2005). Central Europe has been marginal in the discussion about agricultural systems, despite being fully embedded within the LBK world. Recent debates on Neolithic agriculture in Central Europe have focused on two related issues: the formation and long-term preservation of Chernozem(-like) soils in loess landscapes, and the extent to which early farmers-maintained soil fertility through manuring. Pedological studies have shown that relict Chernozems can survive, be transformed, or be degraded under different Holocene land-use trajectories, raising the question of how Neolithic cultivation contributed to these processes (e.g. Kabała et al. 2019, Strouhalová et al. 2020). In parallel, isotopic work on charred crop remains has inferred intensive manuring regimes from elevated $\delta^{15}\text{N}$ values in cereals and pulses, suggesting a close integration of crop production and animal husbandry. In our study we aim to form an innovative extension of the crop-isotope approach directly to Neolithic soils and pit fills. We present isotopic and geochemical data from the LBK settlement of Těšetice–Kyjovice (south of the Czech Republic) situated on Chernozems.

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CHANGES IN CARBON CONTENT AND pH IN BLACK SOIL DURING 70 YEARS OF DIFFERENT FERTILIZATION AND CROP ROTATION

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The aim of the research is to assess the impact of the fertilization system (mineral - NPK, farmyard manure – FYM and mixed mineral and farmyard manure $\frac{1}{2}$ NPK and $\frac{1}{2}$ FYM) and unfertilized/control plot used in two rotations on the changes in soil organic carbon (Corg) content and pH of black soil during 70 years of different fertilization and crop rotation managements. The research was conducted in two long-term static experiments, in which since 1955 this varied mineral and organic fertilization was applied in two crop rotations: A - a rotation without red clover (sugar beet – spring barley – winter rapeseed – winter wheat) and B - a rotation with red clover (sugar beet – spring barley with undersown red clover – red clover – winter wheat).

The experiments were established in Chylice (Central Poland, 52°06'N, 20°33'E) in 1955 on leached black earth (according to WRB – Endogleyic Phaeozems), which developed from sandy loam. Before the experiment was established, the following crops were grown in the field: in 1951-1952 a mixture of grasses and legumes, in 1953 – winter wheat, and in 1954 – potatoes. The arable layer was slightly acidic (pH 6.2–6.5) and contained on average 11,5 g·kg⁻¹ Corg. Since 1955, no liming or fertilization with microelements has been used and fields have been maintained using the plough tillage system.

In 1956, the average Corg content in the red clover-based crop rotation was 13,2 g·kg⁻¹ and 12,3 g·kg⁻¹ in rotation without red clover. Between 1955 and 1962, farmyard manure was applied only once in both full rotations, resulting in an average 5% decrease in organic carbon content in manured and an 18% decrease in unfertilized soil over a 7-year period. From 1962, mineral fertilizer rates were increased, and manure began to be applied to all crops in the rotations - this resulted in a change in the trend in carbon content in manure fertilization fields in subsequent years. In the 1979-1983 period (after 25-28 years), manure fertilization increased organic carbon content by 23% and 17% in comparison with unfertilized plots in rotations A and B, respectively. However, the continuous lack of organic amendment under plough tillage conditions further contributed to the decline in Corg content in the soil in NPK and unfertilized plots. In 1994-1995 (after 39-40 years), soil Corg content was higher in all fertilized treatments compared to the unfertilized plot. In

soil fertilized with manure, this increase was 28%, with NPK fertilization was 15.5% lower than with manure, and with mixed fertilization, it reached intermediate values. At the same time, the clover-based crop rotation resulted in an average increase in soil carbon content by 40% compared to the non-clover crop rotation and a decrease in soil pH (6.1 compared to 6.4). In subsequent years, soil Corg levels remained unchanged or increased minimally under the influence of manure in both crop rotations, while NPK fertilization alone and no fertilization contributed to a further reduction in soil Corg levels, especially in crop rotations without red clover. In the period 2011-2013 (after 56-58 years), the use of manure in the crop rotation without red clover resulted in an increase in the Corg content by 64%, and in the crop rotation with red clover by 35% compared to the treatments without fertilization. After 70 years (in 2025), the soil in the red clover rotation became significantly acidic and the pH decreased to 5.3, while in the rotation without legumes, a higher pH of 5.9 was observed. Average Corg content was significantly higher ($14,8 \text{ g}\cdot\text{kg}^{-1}$) in the soil from the red clover-based (B) rotation compared to the non-legume (A) rotation ($12,8 \text{ g}\cdot\text{kg}^{-1}$). Mineral fertilization alone (NPK) led to a slight deterioration of the Corg content to $11,8 \text{ g}\cdot\text{kg}^{-1}$ (A- $10,4 \text{ g}\cdot\text{kg}^{-1}$; B- $13,1 \text{ g}\cdot\text{kg}^{-1}$) compared to those observed in organically fertilized plots: FYM - $16,7 \text{ g}\cdot\text{kg}^{-1}$ (A- $16,9 \text{ g}\cdot\text{kg}^{-1}$; B- $16,6 \text{ g}\cdot\text{kg}^{-1}$) and $\frac{1}{2}\text{NPK} + \frac{1}{2}\text{FYM}$ - $15,3 \text{ g}\cdot\text{kg}^{-1}$ (A- $14,6 \text{ g}\cdot\text{kg}^{-1}$; B- $16,0 \text{ g}\cdot\text{kg}^{-1}$). Organic and mineral-organic fertilization counteracted the decrease in soil pH, while mineral fertilization led to its reduction. A beneficial effect of manure application on soil pH was observed.

ANTHROPOGENIC TRANSFORMATIONS OF THE SOIL COVER OF WOLIN ISLAND

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Wolin Island, located in the south-western Baltic Sea region, north-west Poland, represents a unique pedological landscape where natural soil-forming processes — postglacial relief, sandy and loamy parent materials, groundwater influence, and flooding by seawater or rivers — have been increasingly overprinted by human activity. As one of Poland's largest islands, encompassing a national park, coastal settlements, agricultural land, and managed forests, Wolin offers an interesting study area for assessing the spatial extent and nature of anthropogenic soil transformations using multi-source cartographic data.

This study aims to (1) identify and spatially delineate areas of anthropogenically transformed soils across Wolin Island, and (2) evaluate the utility of soil maps and other cartographic materials as tools for diagnosing human-induced pedological change at the landscape scale.

The analysis was based on soil-agricultural maps (1:5 000), forest soil-habitat maps (1:10 000) and stand descriptions for managed forests, and a soil survey of Wolin National Park by K. Biały (1998), supplemented with an orthophotomap and topographic databases to identify built-up areas, industrial zones, and drainage ditch networks.

Preliminary results indicate that a substantial proportion of Wolin Island's soil cover shows measurable signs of anthropogenic modification. Urban and industrial areas correspond to sealed or heavily disturbed technogenic soils. Soil-agricultural maps indicate a significant share of eroded clay-illuvial soils in cultivated areas. High drainage ditch density in low-lying areas may indicate degradation of organic soils through oxidation, subsidence, and mineralisation. Forests dominated by *Pinus sylvestris*, largely resulting from 19th- and 20th-century afforestation campaigns, likely exhibit altered humus form and soil acidity compared to natural soils.

Cartographic analysis proves to be an effective, resource-efficient approach for mapping anthropogenic soil transformations at the landscape scale. Nevertheless, cartographic data alone carry inherent limitations that make field verification an indispensable next step.

DIVERSITY OF “BLACK EARTHS” IN KUYAVIA: THE CASE STUDY OF WYBRANOWO

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Kuyavia is one of the principal regions of black earth occurrence in Poland. Owing to the extensive dark-coloured arable surfaces and subdued relief, individual fields are commonly perceived and mapped as internally homogeneous soil units. This study demonstrates the actual pedological diversity of a field near Wybranowo in the so-called Black Kuyavia and identifies the processes responsible for it. A detailed field survey was combined with profile description and analyses of the plough horizon, including total nitrogen, organic carbon, pH, calcium carbonate and texture. Soils were classified according to the Polish Soil Classification (2019). Although the field is dominated by loamy materials and traditionally regarded as a black earth area, it contains a complex soil mosaic related to subtle relief differences, water regime, erosion, colluvial deposition and direct human disturbance. Typical or clay-illuvial Chernozems (!) occur on the highest convex positions, whereas eroded and waterlogged black earths occupy lower summits, nearly level slopes and gently undulating surfaces. Local depressions contain chernozemic colluvial soils, including groundwater-gleyed subtypes. Near a drainage ditch, a strongly disturbed profile with a buried dark horizon was classified as a humic gleyic Aggerosol, probably formed by redistribution of soil material during ditch construction or maintenance. The spatial differentiation is also reflected in topsoil properties. Despite the uniform loamy texture, organic carbon in ploughed Ap horizons ranged from 1.16 to 2.17%, pH (H₂O) from 6.53 to 8.01 and CaCO₃ from 0.2 to 6.8%. Organic-carbon stocks differed markedly among soil groups, with the highest values in chernozemic colluvial soils and the lowest in strongly eroded soils. Thus, fields regarded as representative and homogeneous areas of Kuyavian black earths may comprise several genetically and functionally distinct soil units. Their pattern results from interactions between inherited hydromorphic pedogenesis and long-term agricultural transformation, especially erosion-deposition processes, drainage and local earthworks. Conventional soil maps may therefore substantially underestimate within-field diversity relevant to classification, carbon assessment and precision land management.

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DEVELOPMENT OF THE Bw HORIZON IN BLACK EARTHS FOLLOWING THE GROUNDWATER TABLE DEPTH DECREASE

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Soil investigations were conducted in the area of the long-term agricultural experimental fields (Z-3, Z-4, and U-6) of the Institute of Agriculture of the Warsaw University of Life Sciences (SGGW) in Chylice, with the aim of determining the physical and chemical properties of the soils occurring in the study area and classifying them according to the current guidelines of the Polish Soil Classification (2019) and the World Reference Base for Soil Resources (WRB) (2022). Six soil profiles were studied. Soil samples were collected for laboratory analyses. The investigation included morphological characteristics, particle-size distribution, soil reaction (pH), carbonate content, soil organic matter content, and sorption properties. Field investigations indicated that the studied soils are influenced by groundwater, as evidenced by distinct features of groundwater gleying in the central and lower parts of the soil profiles. Iron nodules were observed in the upper parts of the profiles (below the A horizon) in more humid soils, whereas continuous horizons exhibiting cambic properties were identified in soils with slightly lower moisture conditions. In most profiles, bulk density increased with depth, accompanied by a decrease in total porosity. The studied soils were predominantly characterized by sandy loam texture. The pH(H₂O) values ranged from 6.0 to 8.6 and generally increased with depth. Carbonate content varied from 0 to 16.8%, with calcium carbonate occurring mainly in the subsoil. The contents of total organic carbon (TOC), total nitrogen (TN), and total sulphur (TS) ranged from 0.03 to 1.65%, 0.02 to 0.20%, and 0.007 to 0.028%, respectively. The highest TOC, TN, and TS contents were recorded in the plough horizons (Ap). Hydrolytic acidity (Hh) was highest in the surface horizons (Ap), reaching a maximum value of 8.85 cmol·kg⁻¹. The sum of exchangeable base cations (S) increased with soil depth, reaching values of up to 19 cmol·kg⁻¹. Calcium was the dominant exchangeable base cation in the studied soils. The cation exchange capacity (CEC) varied among horizons, reaching a maximum of 19.3 cmol·kg⁻¹. Base saturation (BS) ranged from 36% to 99%, with the lowest values in the Ap horizons and higher values in the subsoil. According to the Polish Soil Classification (2019), the studied soils were classified as different variants of black earths. According to the World Reference Base for Soil Resources (WRB) (2022), the soils were classified as different variants of Phaeozems and Stagnosols.

STABLE MEAN, CHANGING DISTRIBUTION: LONG-TERM ORGANIC CARBON DYNAMICS IN MORAVIAN CHERNOZEMS

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Moravian soils assigned to the *Chernozem* group in the historical Czech classification cover approximately 255,709 ha and include highly productive agricultural land. Here, “*Chernozems*” denotes this broader national genetic-taxonomic category, not the WRB 2022 Reference Soil Group concept. This study evaluated changes in oxidizable organic carbon (C_{ox}) over approximately five decades by comparing the Czechoslovak Soil Survey (1961–1970) with re-sampling of former representative profile sites in nowadays. Topsoil (0–30 cm) and subsoil (30–60 cm) were assessed separately; comparable C_{ox} data were available for 90 sites in each layer. Values originally reported as humus were converted back to C_{ox} using the Welte factor ($\text{humus} = C_{ox} \times 1.724$). Historical dead-stop chromic-acid titration and the later modified Walkley–Black procedure were compared on 17 samples, with no significant methodological difference. Temporal differences were tested using one-way analysis of variance, together with changes in frequency distributions. Mean topsoil content of C_{ox} increased from 1.50% during the 1961–1970 survey to 1.61% in 2003–2006, an absolute increase of 0.10 percentage points (6.9% relative), but the difference was not statistically significant ($p = 0.16$). Mean subsoil C_{ox} decreased from 1.10% to 1.04%, likewise without statistical significance ($p = 0.42$). Thus, the data provide no evidence of region-wide C_{ox} depletion over the study period. However, stable regional means conceal redistribution: the topsoil frequency distribution became multimodal, while the subsoil distribution remained multimodal but its peaks shifted. This pattern is consistent with spatially uneven management histories, particularly differing fertilizer inputs and the former prevalence of perennial forage crops.

Field Guide

BRIEF ENVIRONMENTAL SETTING

Field sessions of the workshop will take place in SW Poland, on the Wrocław Plain, being a part of the Silesian Lowland, in the altitude range of 127 - 132 m ASL (Fig. 1 and 2).

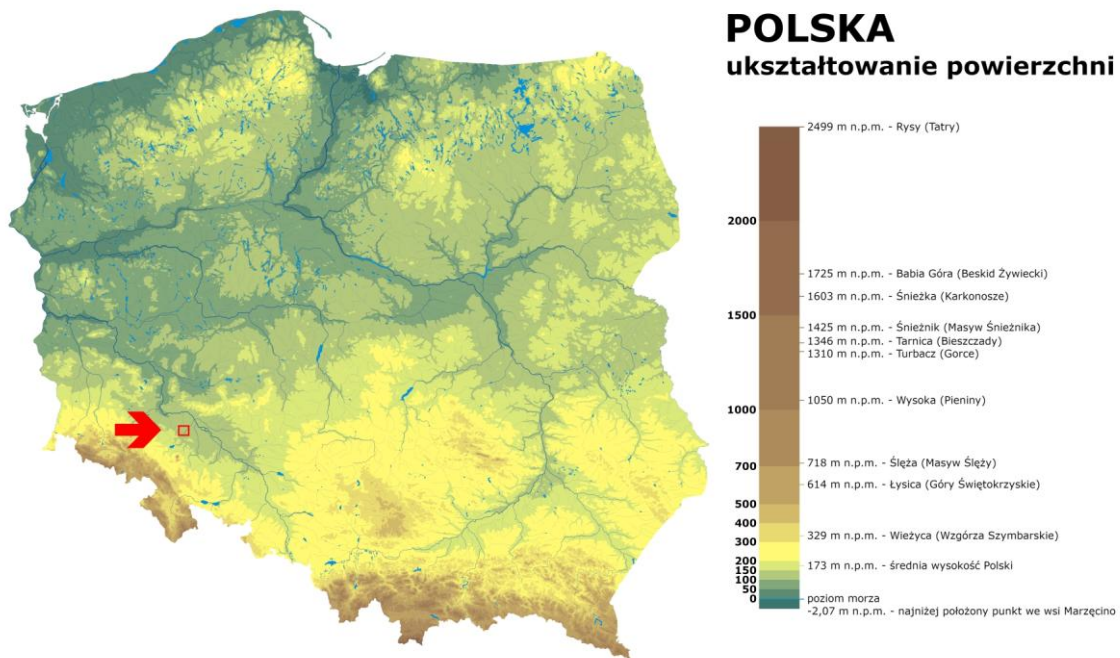


Fig. 1. Location of the workshop sites in SW Poland (Lower Silesia)

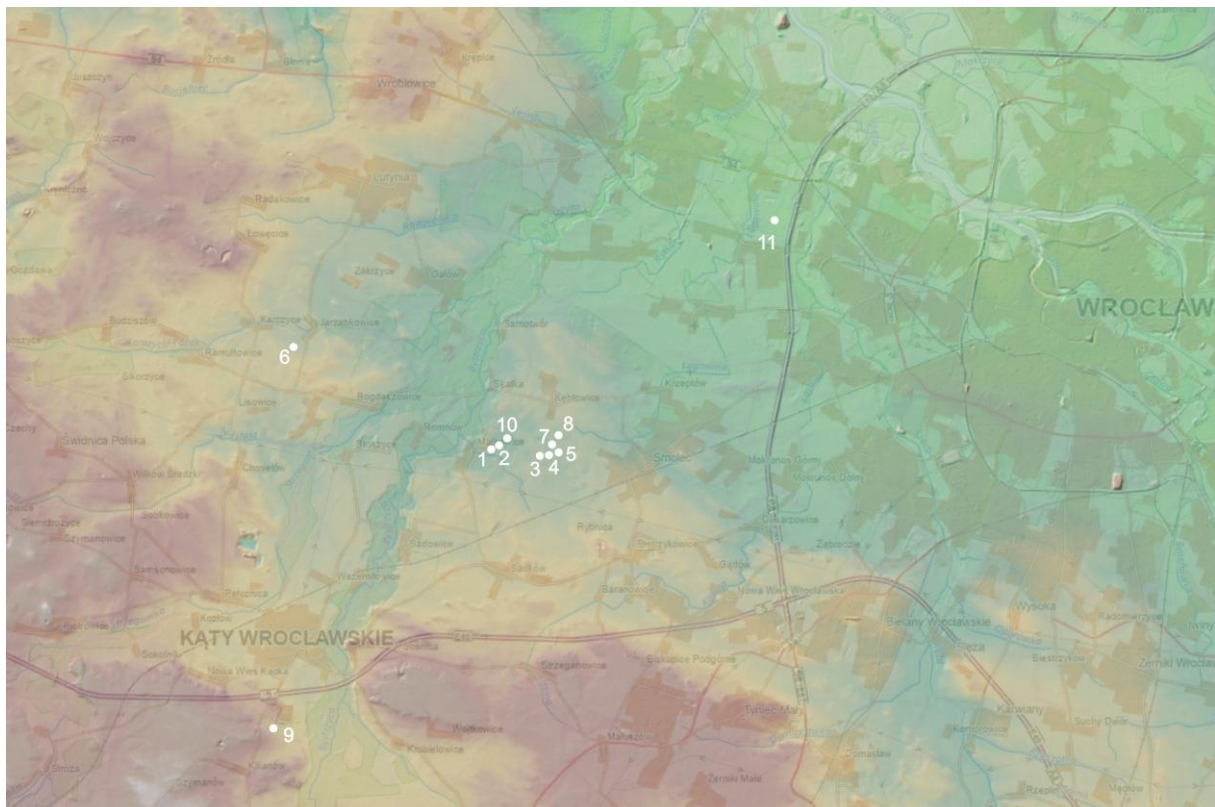


Fig. 2. Location of the soil profiles on a relief map (LIDAR) of the western part of the Wrocław Plain.

The Wrocław Plain is an old denudation surface covered with glacial tills and glaciofluvial sands of the Odra glaciation (Riss 1, Saale – Drenthe), locally covered with thin Vistulian (LGM) loess and loess-like sediments, all settled above thick Miocene clays. Locally, the Quaternary sediments are so thin that Miocene clays emerge within the soil profiles, sometimes even at soil surface.

Field sessions of the workshop are located at the north-western margins of a large black earth region, stretching ca 60 km south of Wrocław (Fig. 3). According to WRB, black soils of the region represent a variety of soils having mollic/chernic horizons and stagnic/gleyic properties at various depth, thus classified as: Gleyic/Stagnic Phaeozems, Gleyic/Stagnic Chernozems, Mollic Gleysols, (Luvic) Mollic Stagnosols, and Mollic Planosols.

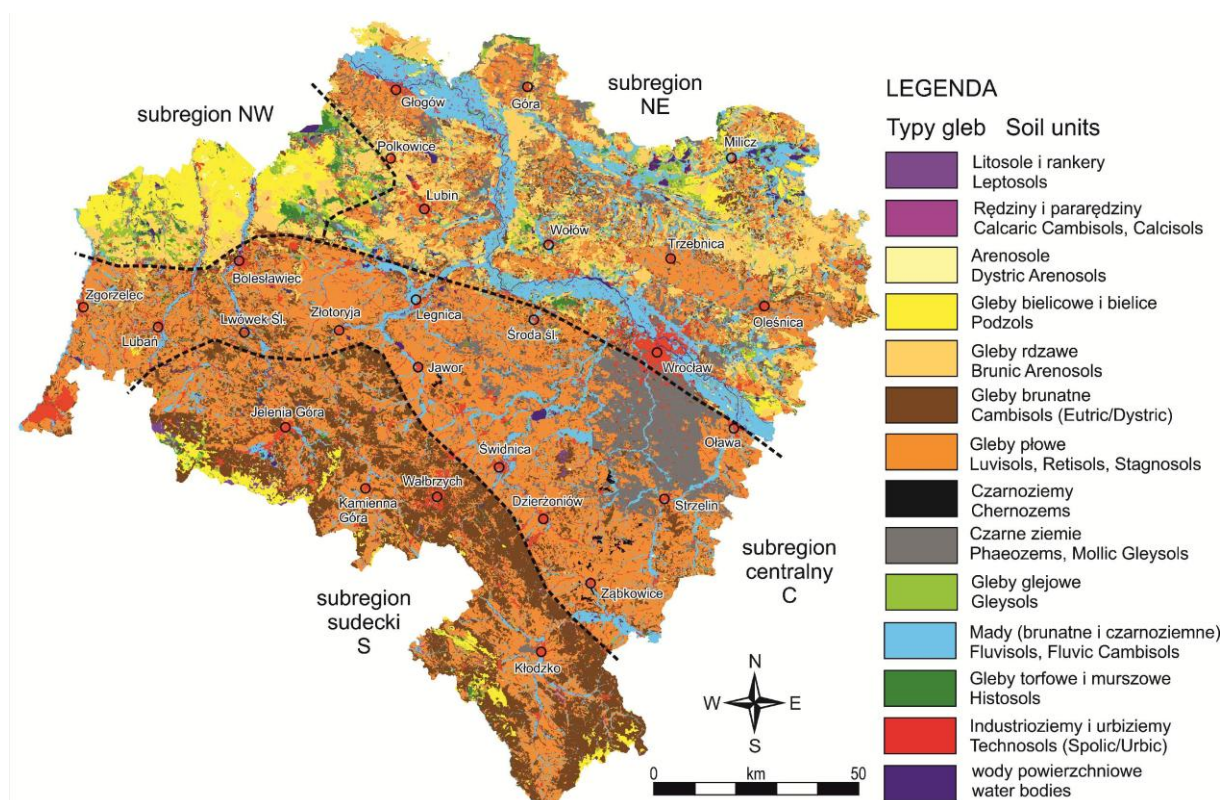


Fig. 3. Black earths (gray surface) on soil map of the Lower Silesia.

The Silesian Lowland is characterized by relatively (compared to other regions of Poland) high mean annual air temperatures of $>8.5^{\circ}\text{C}$ (recently $>9^{\circ}\text{C}$), moderate mean annual precipitation (around 550 mm) and slightly positive climatic water balance (Fig. 4-6).

Good soils, mild climate and plain landscape create beneficial environmental conditions for agriculture, and are reflected in high evaluation values, getting 70-80 credits on a scale of 4-100 credits (Fig. 7). As a result, the area is occupied and farmed permanently since the Neolithic period. Arable fields absolutely dominate the landscape, while forests persisted in the moist river valleys only.

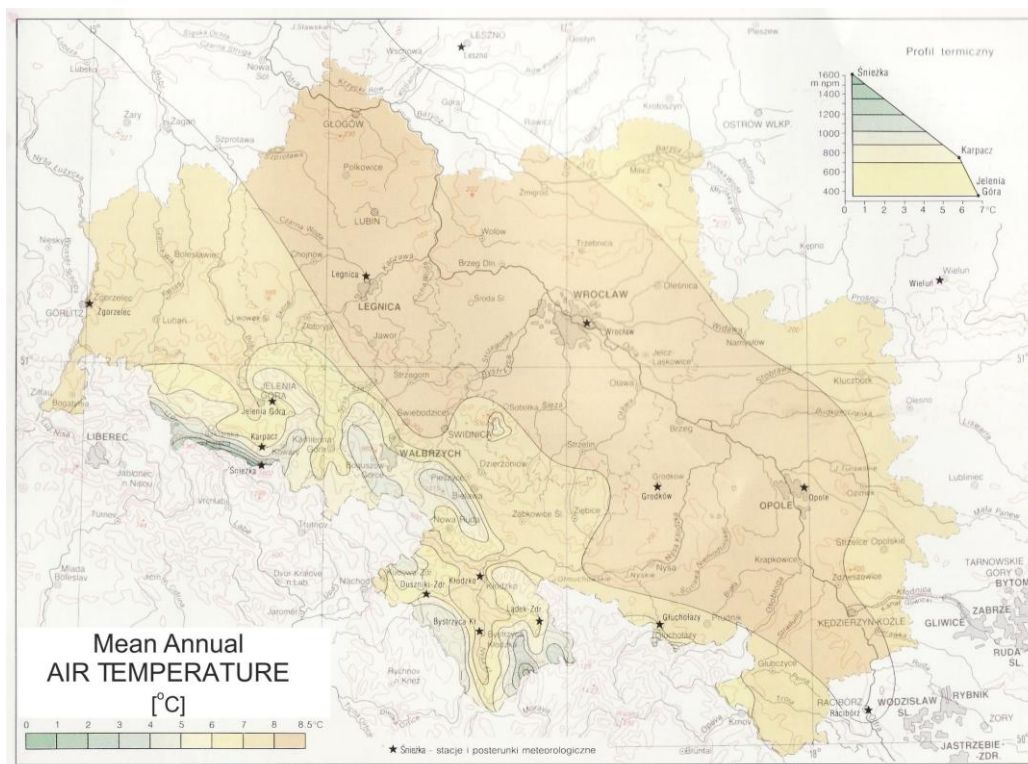


Fig. 4. Mean annual air temperatures (MAP) in the Lower Silesia

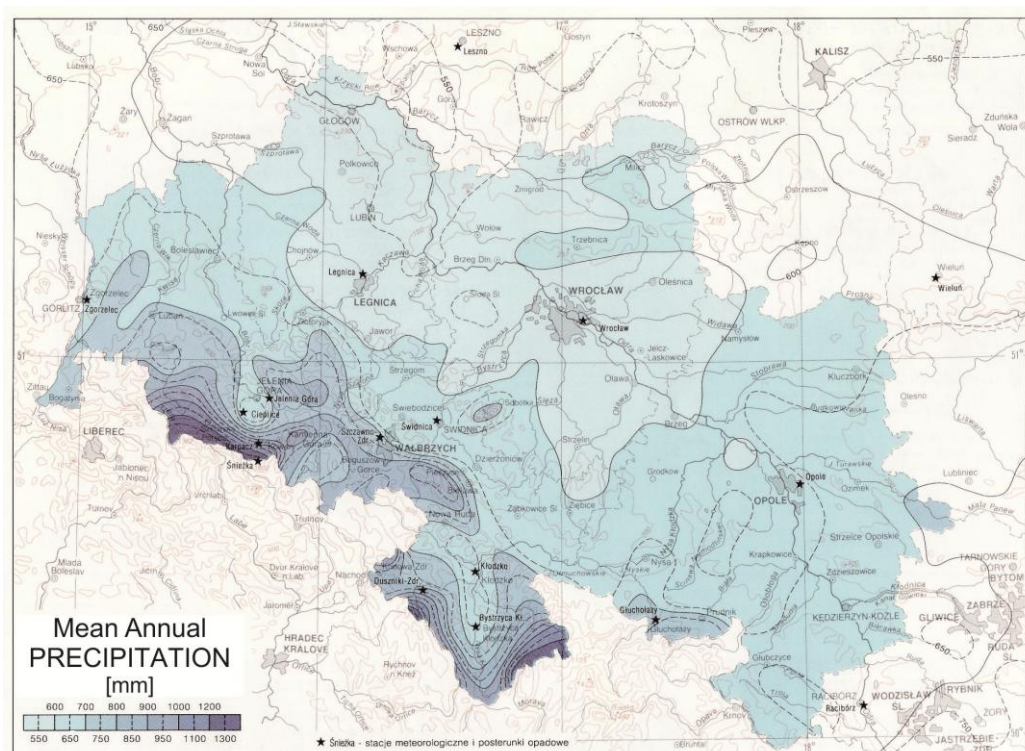


Fig. 5. Mean annual precipitation (MAP) in the Lower Silesia

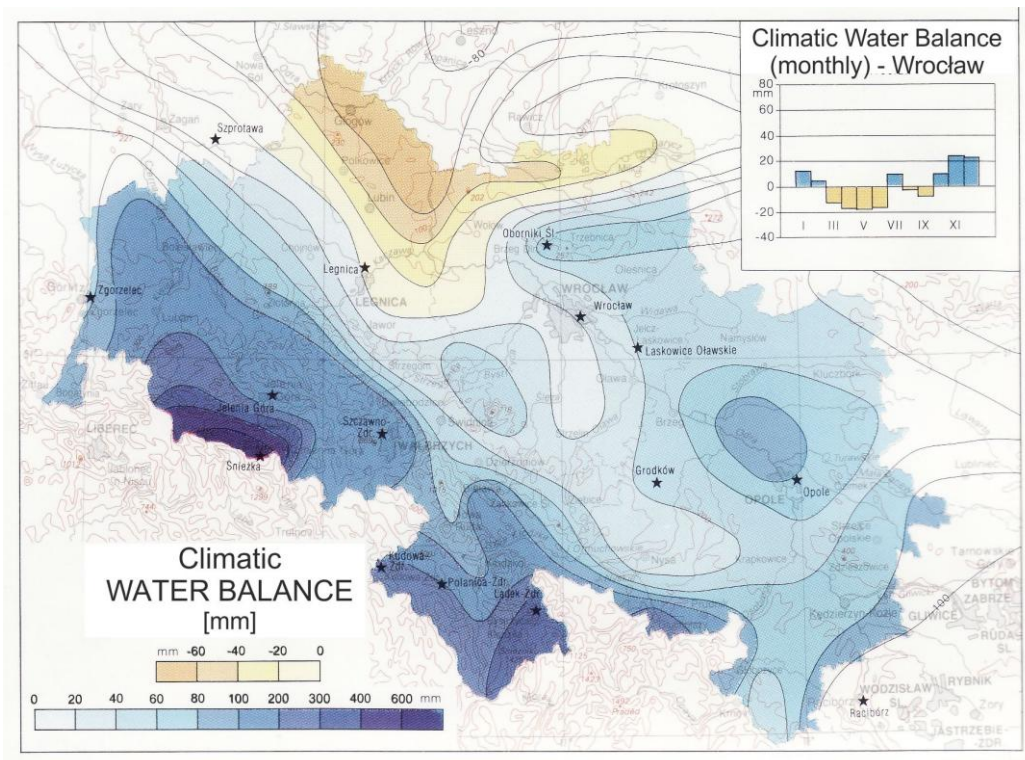


Fig. 6. Climatic water balance (precipitation minus evaporation) in the Lower Silesia

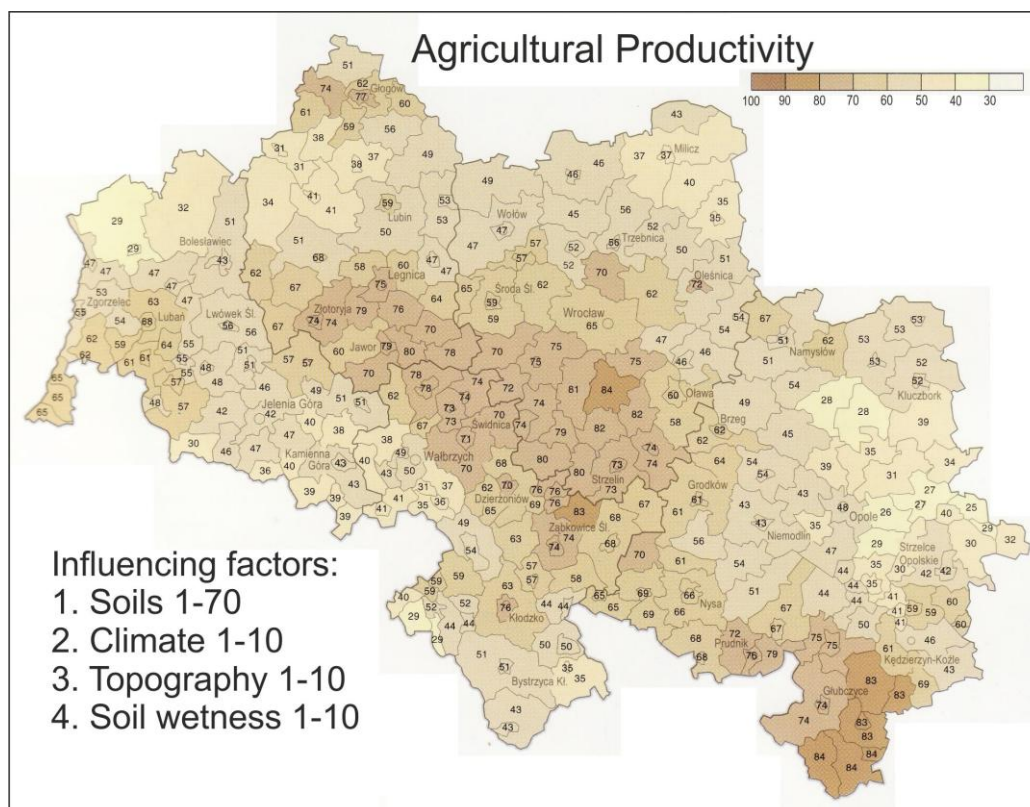


Fig. 7. Evaluation of potential productivity of agricultural space in the Lower Silesia (credit scale from 4 to 100)

The main part of the field sessions is located east of the Małkowice village and divided into two soil sequences (catenas): Małkowice West (profiles 1, 2, 10) and Małkowice East (profiles 4, 5, 7, 8) (Fig. 8). The archival maps, dated back to 1889 confirm the long history of the soil drainage in the Wrocław Plain (Fig. 9). The present-day network of ditches in the surrounding of Małkowice village already existed on these maps, that means the ditches have drained fields for at least 130 years.

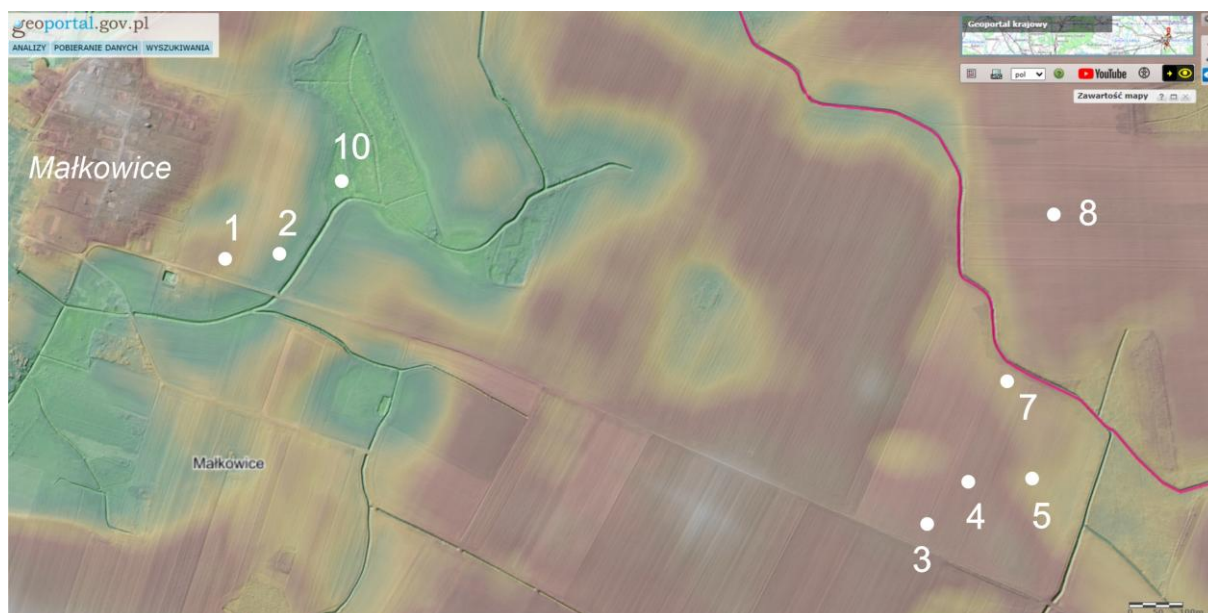


Fig. 8. Soil catenas in Małkowice: location of soil profiles on the LIDAR relief map.

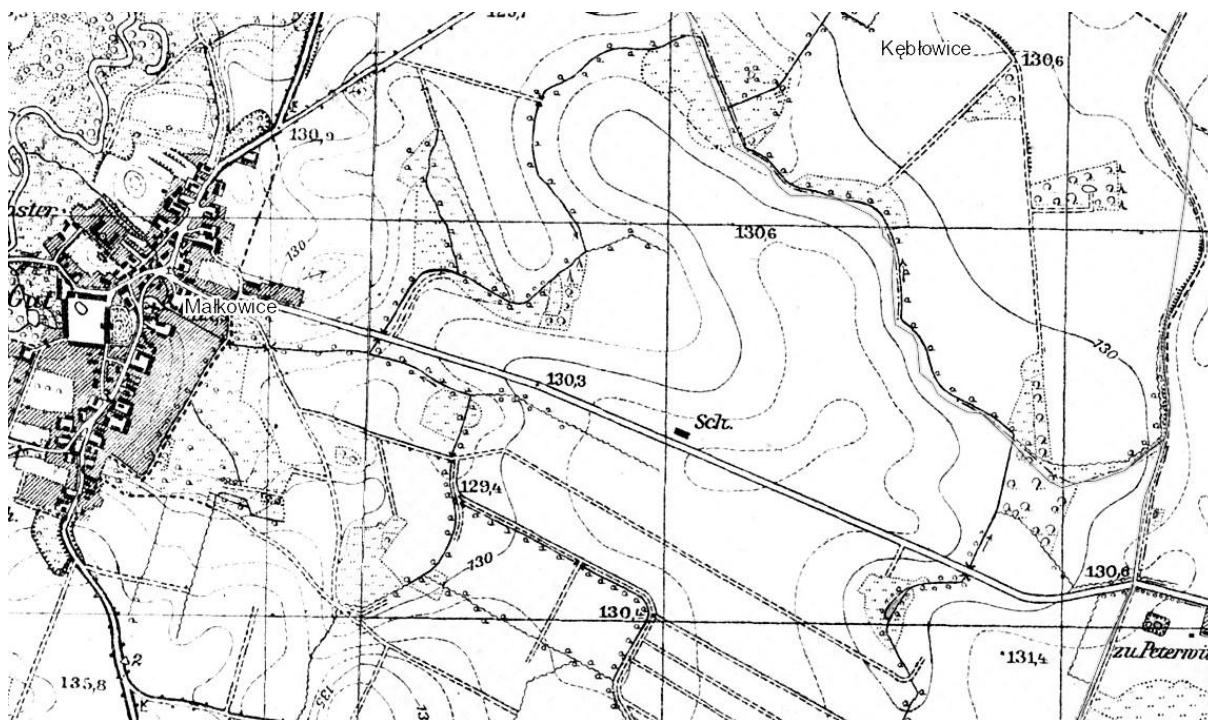


Figure 9. Archival topographic map (1889) of the fields of Małkowice village.

Fig. 10. Soil catena Małkowice West: location of soil profiles on the soil-agricultural map

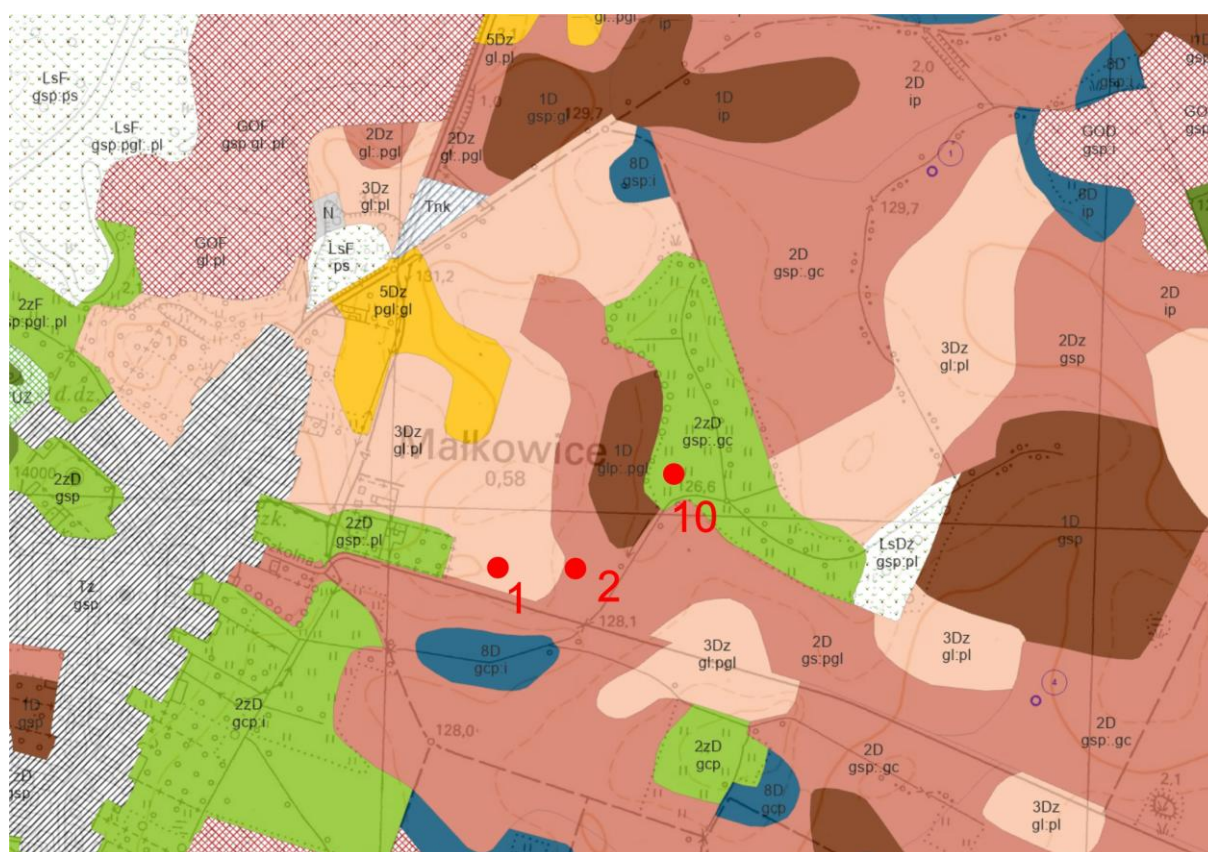
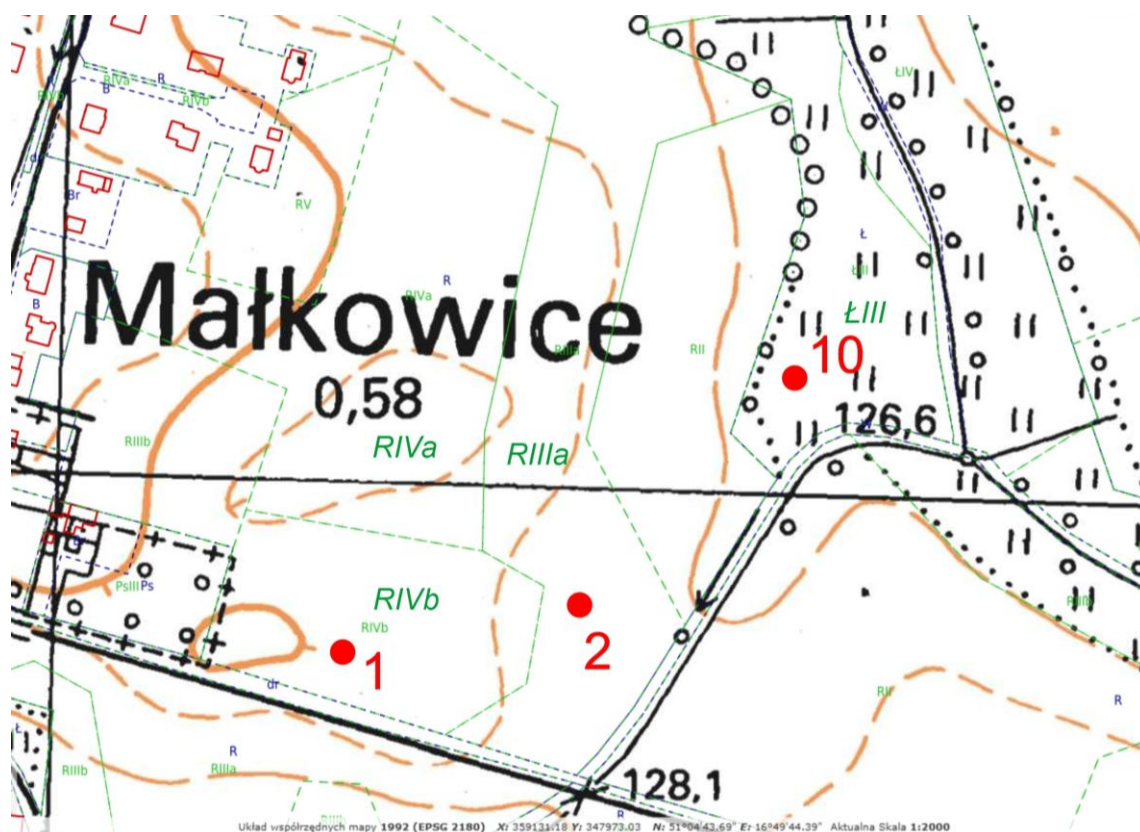


Fig. 11. Soil catena Małkowice West: location of soil profiles on the bonitation map



SOIL PROFILE 01

Localization: Małkowice, 10/5, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates: 51°04'34.8" N, 16°49'46.5" E; PUWG: X 358856, Y 348006
Physiographical units: Silesian Lowland, Wrocław Plain
Altitude: 130 m above sea level
Landform: slightly undulating plain; soil profile located in a higher position on the field
Land use: arable field (2026: corn)
Parent materials: Pleistocene glacial tills and glaciofluvial sands on Miocene clays
Classification WRB2022: (Luvic?) Chernic Phaeozem (Epiloamic, Geoabruptic*, Humic, Bathystagnic)
* abrupt textural difference is too deep as for Planosols
Classification SGP6: Czarna ziemia typowa (iluwialna?)
Original agric. evaluation: class RIVb, complex 3Dz gl:pl



Soil profile 01 description

Horizon SGP	Ap1	Ap2	2BtCg1	2BtCg	3BCg	3BCkg
Horizon WRB	Ap1	Ap2	2BtCg1	2BtCg	3BCg	3BCkg
Depth, cm	0-28	28-47	47-70	70-82	82-105	105-140
Colour, moist	10YR 2/2	10YR 2-3/2	10YR 5/7	10YR 4/6	10YR 5/6	10YR 5/6
Boundary	gradual	clear irreg.	clear smooth	abrupt wavy	gradual	-
Structure	granular/blocky subangular medium	blocky subangular medium	platy/single grain	platy/ blocky subangular fine	blocky angular medium	blocky angular coarse
Consistence	very friable	friable	very friable	friable	firm	firm
Texture	L	L	LS	SL	SiC	SiC
Skeleton	<5%	<5%	0	10% remains of pavement	0	0
Carbonates	(+) lime	-	-	-	(+)	+ soft masses, fine concret.
Reductomorph. features	-	-	20% 10YR 5/4	-	20% 10YR 6/1	40% 5GY 6/1
Oximorphic features	-	-	-	20% 7.5YR 5/6	80%	60%
Redox accumulations	-	-	-	fine FM masses	very fine Mn masses	fine Mn masses
Clay accumul.	-	-	lamellae?	lamellae?	-	-
Slickensides	-	-	-	-	-	-
Earthworm channels/coasts	++	++	+	+	+	-
Other	-	-	-	ventifacts	-	-
Diagnostics	chernic	chernic	-	argic?	stagnic	stagnic protocalcic

Analytical data for soil profile 01

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002	sand	silt	clay	
		%	%									%			
Ap1	0-28	<5	2.5	9.5	20	13	8	19	13	6	9	53	38	9	L
Ap2	-47	<5	2.5	9	21	11.5	10	19	11	6	10	54	36	10	L
2BtCg1	-70	0	11	21	32	13	6	6	4	1	6	83	11	6	LS
2BtCg2	-82	10	4	15	33	17	9	7	3	1	11	78	11	11	SL
3BCg	-105	0	0.3	0.4	1	0.3	2	4	27	15	50	4	46	50	SiC
3BCkg	-140	0	0.1	0.3	0.6	1	2	7	25	15	49	4	47	49	SiC

Explanation: L - loam (głina zwykła), LS - loamy sand (piasek gliniasty), SL – sandy loam (głina piaszczysta), SiC – silty clay (ił pyłasty)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-28	1.70	1.27	0.10	13	0.6	6.7	5.9
Ap2	-47	1.75	0.71	0.05	13	0	7.1	6.1
2BtCg1	-70	1.64	0.25	0.01	25	0	7.4	6.4
2BtCg2	-82	-	0.20	0.01	20	0	7.8	6.6
3BCg	-105	1.56	0.19	0.03	-	1	7.9	6.6
3BCkg	-140	-	0.17	0.01	-	6	8.3	6.8

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-28	0.76	0	5.0	0.70	0.56	0.02	6.3	7.0	7.5	89	100	84
Ap2	-47	0.3	0	5.1	0.66	0.36	0.02	6.1	6.4	7.4	95	100	83
2BtCg1	-70	0.2	0	4.6	0.43	0.16	0.02	5.2	5.4	5.8	96	100	90
2BtCg2	-82	0.2	0	6.5	0.94	0.28	0.04	7.7	7.9	8.2	97	100	95
3BCg	-105	0	0	20.8	3.83	0.43	0.19	25.2	25.2	26.0	100	100	97
3BCkg	-140	0	0	35.4	4.32	0.40	0.22	40.3	40.3	28.0	100	100	100

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $sBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

SOIL PROFILE 02

Localization: Małkowice, 10/25, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates: 51°04'35.1" N, 16°49'52.8" E; PUWG: X 358863, Y 348130
Physiographical units: Silesian Lowland, Wrocław Plain
Altitude: 128 m above sea level
Landform: slightly undulating plain; soil profile located in a lower position on the field, drained by ditch
Land use: arable field (2026: corn)
Parent materials: Pleistocene glacial tills and glaciofluvial sands on Miocene clays
Classification WRB2022: Cambic Stagnic Chernozem (Loamic, Humic, Pachic, Sombric, Geoabruptic*); Vertic or Protovertic should be discussed
* abrupt textural difference is too deep as for Planosols
Classification SGP6: Czarna ziemia zbrunatniała wertikowa
Original agric. evaluation: class RIIIa, complex 2D gs:pgl



Soil profile 02 description

Horizon SGP	Ap1	Ap2(b)	ABg	Bwg	Bkg	2Bikg
Horizon WRB	Ap1	Ap2(b)	ABg	Bwg	Bkg	2Bikg
Depth, cm	0-32	32-50	50-60	60-70	70-95	95-150
Colour, moist	10YR 2/1	10YR 1/1	10YR 4/1	7.5YR 6/6	10YR 6/6	10YR 6/6
Boundary	clear smooth	gradual	gradual	irregular	abrupt/clear irregular	-
Structure	granular/blocky subangular medium	blocky angular medium	blocky subangular fine	blocky subangular fine	blocky angular fine/medium	blocky angular medium
Consistence	very friable	friable	very friable	friable	firm	very firm
Texture	SL	SL	SL	SL	SL	C
Skeleton	<5%	<5%	<5%	<5%	10% remains of pavement	0
Carbonates	-	-	-	-	(+)	++ fine concret.
Reductomorph. features	-	-	50% 10YR 5/4	30% 10YR 5/4	60% 10YR 5/4	25% 5GY 6/1
Oximorphic features	-	-	-	70%	40%	75%
Redox accumulations	-	-	fine FM masses	very fine Mn masses	very fine Mn masses	very fine Mn masses
Clay accumul.	-	-	-	-	-	-
Slickensides	-	-	-	-	-	++
Earthworm channels/coasts	++	++	++	+	+	+
Other	brick fragm.	-	-	-	-	vert. cracks
Diagnostics	chernic	chernic sombric	stagnic	stagnic	stagnic	stagnic (proto)vertic protocalcic

Analytical data for soil profile 02

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002	sand	silt	clay	
		%	%									%			
Ap1	0-32	<5	3	10	19	10	11	21	12	6	8	53	39	8	SL
Ap2(b)	-50	<5	2	8	19	12	10	18	12	6	13	51	36	13	SL*
ABg	-60	<5	4	13	23	14	8	15	8	2	13	62	25	13	SL*
Bwg	-70	<5	2.7	9.8	20.2	12.3	9	19	11	3	13	54	33	13	SL*
Bkg	-95	10	2	10	19	13	8	19	12	3	14	52	34	14	SL*
2Bikg	-150	0	0.2	1.7	3.1	3	4	1	10	14	63	12	25	63	C*

Explanation: SL – sandy loam (glina piaszczysta), SL* - sandy loam (glina lekka), C* – clay (ił ciężki)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-32	1.54	0.72	0.07	10	0	7.5	6.4
Ap2(b)	-50	1.65	1.31	0.12	11	0	7.2	6.4
ABg	-60	1.7	0.50	0.02	34	0	7.9	7.1
Bwg	-70	1.64	0.31	0.01	29	0	8.2	7.2
Bkg	-95	1.72	0.23	0.03		3.2	8.2	7.3
2Bikg	-150	1.52	0.37	0.05		8.1	8.3	7.3

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-32	0.3	0	10.5	0.87	0.17	0.03	11.5	11.8	13.3	97	100	87
Ap2(b)	-50	0.24	0	11.3	1.23	0.64	0.04	13.2	13.4	13.9	98	100	95
ABg	-60	0	0	10.6	0.68	0.13	0.03	11.4	11.4	11.9	100	100	96
Bwg	-70	0	0	11.3	0.71	0.10	0.03	12.1	12.1	12.3	100	100	99
Bkg	-95	0	0	21.9	1.23	0.15	0.06	23.4	23.4	13.5	100	100	100
2Bikg	-150	0	0	38.3	7.24	0.39	0.22	46.1	46.1	27.3	100	100	100

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V = S \cdot 100 / T$, **eBS** – effective base saturation $sBS = S \cdot 100 / S + Al^{3+}$, **BS** – ‘real’ base saturation $BS = S \cdot 100 / CEC$

SOIL PROFILE 10

Localization:	Małkowice, 10/19, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°04'39.4" N, 16°49'57.9" E; PUWG: X 358990, Y 348232
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	127 m above sea level
Landform:	slightly undulating plain; soil profile located in a shallow concave basin drained by deep ditches; water stagnates on the surface in spring and after heavy rains
Land use:	in the past: meadow; presently: fallow; mainly sedges (<i>Carex</i> spp.), poplar (<i>Populus</i> spp.)
Parent materials:	Pleistocene glacial tills and glaciofluvial sands on Miocene clays
Classification WRB2022:	Cambic Chernozem (Loamic, Endoraptic, Humic, Pachic, Sombric, Stagnic); Vertic or Protovertic should be discussed
Classification SGP6:	Czarna ziemia typowa
Original agric. evaluation:	class ŁIII, complex 2zD gsp:gz



Soil profile 10 description

Horizon SGP	Ap	Apg	2ABkgg	3Btkg	3Bikg
Horizon WRB	Ap	Apg	2ABkr	3Btkg	3Bikg
Depth, cm	0-22	22-31	31-35	35-60	60-90
Colour, moist	10YR 3/1	2.5Y 2-3/1	2.5Y 3/1	10YR 6/6	10YR 6/6
Boundary	gradual	gradual	irregular	gradual	-
Structure	blocky subangular fine-medium	blocky subangular fine-medium	blocky subangular fine	blocky angular medium	blocky angular/wedge medium
Consistence	friable	friable	friable	firm	firm
Texture	SiL	L	L	C	C
Skeleton	<5%	<5%	10	0	0
Carbonates	+ (lime?)	+	+	+	+
Reductomorph. features	-	-	50% 2.5Y 7/1	25% 10G 7/1	40% 10GY 7/1
Oximorphic features	-	-	-	75%	60%
Redox accumulations	-	-	-	very fine FM masses	very fine FM masses
Clay accumul.	-	-	-	coatings	-
Slickensides	-	-	-	+	++
Earthworm channels/coasts	+	+	+	-	-
Other	-	-	-	-	-
Diagnostics	chernic	chernic	stagnic (+gleyic?)*	argic? stagnic	stagnic protovertic

* Note criterion 5 of the stagnic properties (WRB 2022).

Analytical data for soil profile 10

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	< 0.002	sand	silt	clay	
		%	%									%			
Ap	0-22	<5	2.5	5	11.5	9	8	28	18	7	11	36	53	11	SiL*
Apg	-31	<5	2	5.5	11	9.5	8	20	20	5	19	36	45	19	L
2ABkgg	-35	10	2.5	5	10	9.5	7	13	17	10	26	34	40	26	L
3Btkg	-60	0	0	1	2	2	3	2	15	19	56	8	36	56	C
3Bikg	-90	0	0	1	1	2	2	1	14	23	56	6	38	56	C

Explanation: SiL* – silt loam (pył gliniasty), L - loam (glina zwykła), C – clay (ił zwykły)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap	0-22	-	3.04	0.32	9	1.3	7.3	7.0
Apg	-31	-	1.67	0.13	13	4.5	8.2	7.5
2ABkgg	-35	-	1.01	0.07	-	10.3	8.3	7.5
3Btkg	-60	-	0.62	0.08	-	10.1	8.2	7.3
3Bikg	-90	-	0.42	0.06	-	5.7	8.3	7.5

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap	0-22	0.1	0	27.2	3.82	0.62	0.34	32.0	32.1	21.8	100	100	100
Apg	-31	0	0	40.3	2.79	0.22	0.20	43.5	43.5	17.9	100	100	100
2ABkkg	-35	0	0	51.7	3.67	0.24	0.23	55.8	55.8	16.4	100	100	100
3Btkg	-60	0	0	49.8	7.11	0.43	0.39	57.8	57.8	31.0	100	100	100
3Bikg	-90	0	0	41.3	7.44	0.47	0.38	49.6	49.6	35.3	100	100	100

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $sBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

[illegible]

SOIL PROFILE 03

Localization:	Małkowice, 11/6, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°04'19.5" N, 16°50'59.7" E; PUWG: X 358343, Y 349415
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	131.5 m above sea level
Landform:	soil profile located in a higher position on the field
Land use:	arable field (2026: wheat)
Parent materials:	Pleistocene glacial tills and glaciofluvial sands on Miocene clays
Classification WRB2022:	Eutric Chernic Planosol (Epiloamic, Endoclayic, Aric, Raptic, Protocalcic, Protovertic, Brunic)
Classification SGP6:	Czarna ziemia typowa
Original agric. evaluation:	class RIVb, complex 3D gl:pl



Soil profile 03 description

Horizon SGP	Ap1	Ap2	2Bvg	2Bkcg	2Bikg
Horizon WRB	Ap1	Ap2	2Bwg	2Bkcg	2Bikg
Depth, cm	0-12	12-40	40-60	60-85	85-150
Colour, moist	10YR 2/2	10YR 2-3/2	10YR 5/8	10YR 6/6	10YR 6/6
Boundary	gradual	abrupt smooth	clear wavy	gradual	-
Structure	blocky subangular fine/medium	blocky subangular/angular fine	blocky subangular fine	blocky angular medium	blocky angular/wedge medium
Consistence	friable	friable	loose/very friable	firm	very firm
Texture	SL	SL	LS	C	C
Skeleton	0	0	10% remain of pavement	0	0
Carbonates	-	-	-	++ fine concret.	+ dispersed
Reductomorph. features	-	-	-	15% 5GY 6/1	25% 5GY 6/1
Oximorphic features	-	-	20% 10YR 6/6	85%	75%
Redox accumulations	-	-	fine Fe masses	very fine Mn masses	very fine Mn masses
Clay accumul.	-	-	-	-	-
Slickensides	-	-	-	-	++
Earthworm channels/coasts	++	++	++	+	-
Other	-	-	-	-	-
Diagnostics	chernic	chernic	(brunic)	stagnic protocalcic	stagnic (proto)vertic

Analytical data for soil profile 03

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	< 0.002	sand	silt	clay	
		%	%									%			
Ap1	0-12	0	3	9	13	12	12	16	14	6	15	49	36	15	SL*
Ap2	-40	0	4	11.3	20.3	12.4	8	12	14	4	14	56	30	14	SL*
2Bvg	-60	10	13	21	28	18	3	3	2	3	9	83	8	9	LS
3Bkcg	-85	0	0.6	1.4	1	1	2	2	23	15	54	6	40	54	C
3Bkig	-150	0	0.5	0.5	1	1	1	2	15	18	61	4	35	61	C*

Explanation: SL* – sandy loam (glina lekka), LS – loamy sand (piasek gliniasty), C – clay (ił zwykły), C* – clay (ił ciężki)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-12	1.52	1.45	0.12	12	0	6.0	5.0
Ap2	-40	1.60	1.33	0.10	13	0	6.2	5.1
2Bvg	-60	1.55	0.41	0.02	24	0	6.9	5.8
3Bkcg	-85	1.54	0.30	0.04	-	5.7	8.0	6.9
3Bkig	-150	1.59	0.26	0.03	-	4.2	8.1	7.1

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-12	2.14	0	8.5	1.28	0.83	0.05	10.7	12.8	16.5	83	100	65
Ap2	-40	1.92	0	7.9	0.97	0.38	0.04	9.3	11.3	13.2	83	100	71
2Bvg	-60	0.05	0	4.0	1.51	0.29	0.03	5.8	5.9	6.0	99	100	97
3Bkcg	-85	0	0	31.9	6.77	0.30	0.14	39.1	39.1	25.0	100	100	100
3Bkig	-150	0	0	29.4	10.6	0.44	0.23	40.7	40.7	29.3	100	100	100

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $sBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

SOIL PROFILE 04

Localization:	Małkowice, 11/6, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°04'23.3" N, 16°51'00.3" E; PUWG: X 358457, Y 349441
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	131 m above sea level
Landform:	soil profile located in a higher position on the field
Land use:	arable field (2026: wheat)
Parent materials:	Pleistocene glacial tills and glaciofluvial sands on Miocene clays
Classification WRB2022:	Stagnic Chernic Phaeozem (Loamic, Aric, Raptic, Relictiturbic)
Classification SGP6:	Czarna ziemia typowa
Original agric. evaluation:	class RIIIa, complex 2D gsp



Soil profile 04 description

Horizon SGP	Ap1	Ap2	ABwg	2BCg	2BCg@	2BCgg@	3BCg
Horizon WRB	Ap1	Ap2	ABwg	2BCg	2BCg@	2BC(l)@p	3BCg
Depth, cm	0-13	13-35	35-50	50-65	65-90	90-120	120-150
Colour, moist	10YR 3/1	10YR 3/2	10YR 4/3	10YR 5/3	10YR 6/2	10YR 7/1	10YR 6/1
Boundary	abrupt smooth	clear wavy	gradual	clear wavy	clear irreg.	clear wavy	-
Structure	granular/ blocky subangular fine	granular/ blocky angular fine	blocky subangular fine	blocky subangular fine	blocky subangular /single grain	single grain	blocky angular/ platy
Consistence	friable	friable	very friable	very friable	very friable /loose	loose	firm
Texture	L	L	L	SL+S	SL+S	S	SL+L
Skeleton	<5%	<5%	10%	10%	30% remains of pavement	0	0
Carbonates	-	-	-	-	-	-	-
Reductomorph. features	-	-	-	40%	50%	90%	50%
Oximorphic features	-	-	20% 10YR 4/6	30% 10YR 6/3	50% 10YR 5/8	10% 10YR 5/8	50% 10YR 6/8
Redox accumulations	-	-	-	fine FM masses	very fine Mn masses	-	very fine Mn masses
Clay accumul.	-	-	-	-	-	-	-
Slickensides	-	-	-	-	-	-	-
Earthworm channels/coasts	++	++	+	+	+	+	-
Other	-	-	-	-	relict cryoturbation		
Diagnostics	chernic	chernic	stagnic	stagnic	stagnic	gleyic?*	stagnic

* Note criterion 5 of the stagnic properties (WRB 2022).

Analytical data for soil profile 04

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002	sand	silt	clay	
		%	%									%			
Ap1	0-13	<5	1	7.5	17.5	7	12	22	15	5	13	45	42	13	L
Ap2	-35	<5	1	5.5	19	7.5	12	20	16	6	13	45	42	13	L
ABwg	-50	10	1	7	15	5	12	23	13	5	19	40	41	19	L
2BCg	-65	10	1.3	9	35	12.7	6	15	5	1	15	64	21	15	SL*
2BCg@	-90	30	2.3	15	36	15.7	7	7	3	1	13	76	11	13	SL
2BCgg@	-120	0	5	20	58	14	1	0	0	1	1	98	1	1	S*
3BCg	-150	0	2	9	21	18	16	9	8	2	15	66	19	15	SL

Explanation: L – loam (glina zwykła), SL – sandy loam (glina piaszczysta), SL* – sandy loam (glina lekka), S* – sand (piasek luźny)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-13	1.54	1.29	0.12	11	0	6.0	5.1
Ap2	-35	1.60	1.08	0.10	11	0	5.9	5.0
ABwg	-50	1.67	0.51	0.05	10	0	6.5	5.3
2BCg	-65	1.63	0.30	0.02	-	0	6.8	5.5
2BCg@	-90	-	0.24	0.01	-	0	7.2	5.8
2BCgg@	-120	1.7	0.06	0.01	-	0	7.2	5.9
3BCg	-150	-	0.09	0.01	-	0	7.3	6.1

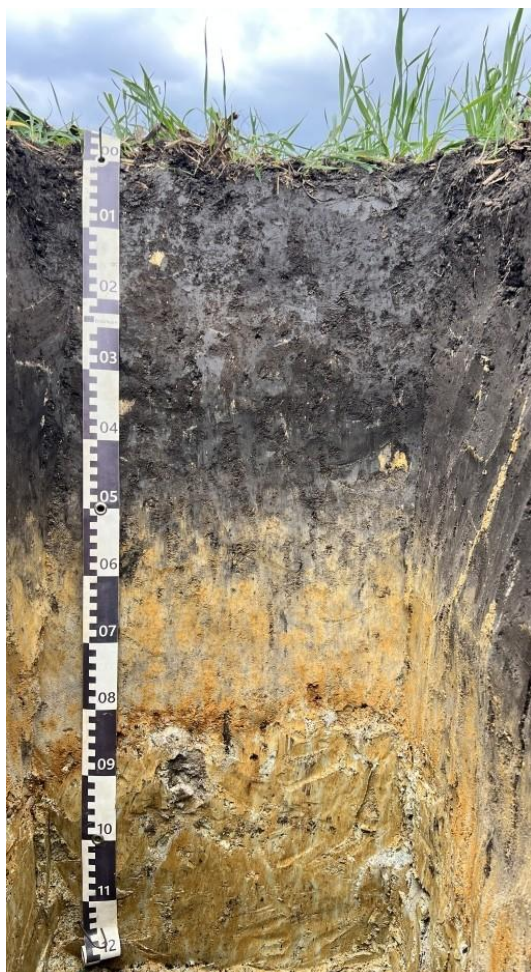
Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-13	2.22	0	6.22	0.72	0.82	0.03	7.8	10.0	13.2	78	100	59
Ap2	-35	2.58	0	6.42	0.59	0.37	0.03	7.4	10.0	12.5	74	100	59
ABwg	-50	0.66	0	6.64	0.88	0.25	0.04	7.8	8.5	13.4	92	100	58
2BCg	-65	0.22	0	5.17	0.74	0.19	0.03	6.1	6.4	9.0	97	100	68
2BCg@	-90	0.05	0	4.72	0.49	0.14	0.02	5.4	5.4	6.5	99	100	83
2BCgg@	-120	0.05	0	0.83	0.28	0.08	0.01	1.2	1.3	1.6	96	100	75
3BCg	-150	0	0	6.07	1.05	0.18	0.04	7.3	7.3	8.1	100	100	90

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** – Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** – extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $sBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

SOIL PROFILE 05

Localization:	Małkowice, 11/6, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°04'22" N, 16°51'06" E; PUWG: X 358417, Y 349543
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	129 m above sea level
Landform:	soil profile located in an intermediate position on the field
Land use:	arable field (2026: wheat)
Parent materials:	Pleistocene loess-like sediments and glacial tills on Miocene clays
Classification WRB2022:	Haplic Chernozem (Anosiltic, Humic, Pachic, Stagnic, Geoabruptic*, Protovertic) * abrupt textural difference is too deep as for Planosols
Classification SGP6:	Czarna ziemia typowa
Original agric. evaluation:	class RII, complex 1D gsp



Soil profile 05 description

Horizon SGP	Ap1	Ap2	Ap3(b)	ABkg	2Bkg	3Bikcg	3Bikg
Horizon WRB	Ap1	Ap2	Ap3(b)	ABkg	2Bkg	3Bikcg	3Bikg
Depth, cm	0-18	18-35	35-50	50-60	65-85	90-100	100-150
Colour, moist	10YR 1-2/1	10YR 2/2	10YR 2/1	10YR 5/2	10YR 5/6	10YR 6/6	10YR 6/6
Boundary	clear smooth	clear wavy	gradual	gradual	clear wavy	gradual	-
Structure	granular/ blocky subangular fine	blocky subangular fine	blocky angular medium	blocky subangular fine	blocky subangular fine	blocky angular/ wedge	blocky angular/ wedge
Consistence	very friable	friable	friable	very friable	very friable	firm	firm
Texture	SiL	SiL	SiL	SiL	SL	C	C
Skeleton	<5%	<5%	<5%	0	5 remains of pavement	15% remains of pavement	0
Carbonates	-	-	-	+	+	++ soft masses fine nodulae pendants	++
Reductomorph. features	-	-	-	30% 10YR 6/2	40% 10YR 6/2	40% 10YR 6/1	40% 10YR 6/1
Oximorphic features	-	-	-	-	60%	60%	60%
Redox accumulations	-	-	-	-	fine FM masses	fine Mn masses	fine Mn masses
Clay accumul.	-	-	-	-	-	-	-
Slickensides	-	-	-	-	-	++	++
Earthworm channels/coasts	++	++	+	+	+	-	-
Other	-	-	-	-	FM nodulae above transition to 3Bikcg	-	-
Diagnostics	chernic	chernic	chernic	stagnic	stagnic	stagnic protovertic protocalcic	stagnic protovertic calcic?

Analytical data for soil profile 05

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002	sand	silt	clay	
		%	%									%			
Ap1	0-18	<5	1	4	10	6	9	27	18	10	15	30	55	15	SiL*
Ap2	-35	<5	1	4	10	6	8	25	20	9	17	29	54	17	SiL*
Ap(b)3	-50	<5	0.5	2.5	7	4	12	29	18	6	21	26	53	21	SiL*
ABkg	-60	0	0.3	2.5	7.2	5	11	32	18	6	18	26	56	18	SiL*
2BCkg	-85	0	1	6	25	12	10	22	10	3	11	54	35	11	SL*
3BCikcg	-100	15	1.3	2.5	5	2.2	3	2	22	14	48	14	38	48	C
3BCikg	-150	0	0.5	1	1.5	1	2	4	23	13	54	6	40	54	C

Explanation: SiL* – silt loam (pył ilasty), SL* – sandy loam (glina lekka), C – clay (ił zwykły)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-18	1.62	2.16	0.16	13	0	7.5	6.8
Ap2	-35	1.65	2.03	0.14	15	0	7.7	7.0
Ap(b)3	-50	-	1.67	0.10	18	4	7.9	7.0
ABkg	-60	-	0.75	0.09	11	2	8.0	7.2
2BCkg	-85	1.65	0.26	0.02	-	3	8.1	7.4
3BCikcg	-100	-	0.32	0.04	-	5	8.3	7.5
3BCikg	-150	1.62	0.20	0.03	-	17	8.3	7.5

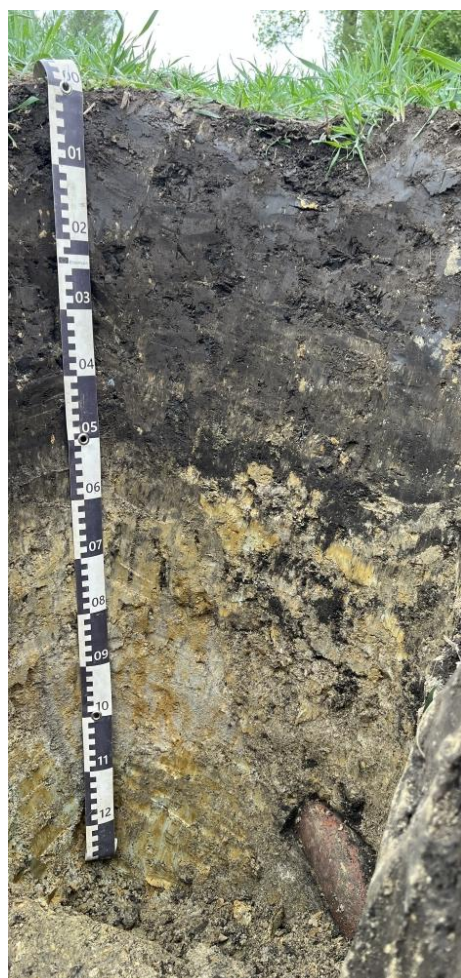
Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-18	0	0	24.0	0.99	0.43	0.06	25.4	25.4	23.5	100	100	100
Ap2	-35	0	0	24.9	0.73	0.21	0.06	25.9	25.9	24.1	100	100	100
Ap(b)3	-50	0	0	27.8	0.75	0.18	0.08	28.9	28.9	17.5	100	100	100
ABkg	-60	0	0	20.5	0.90	0.11	0.05	21.5	21.5	14.0	100	100	100
2BCkg	-85	0	0	19.6	1.36	0.13	0.06	21.2	21.2	7.6	100	100	100
3BCikcg	-100	0	0	24.6	4.05	0.25	0.12	29.0	29.0	22.3	100	100	100
3BCikg	-150	0	0	45.5	6.26	0.31	0.16	52.2	52.2	26.9	100	100	100

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $sBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

SOIL PROFILE 07

Localization:	Małkowice, 11/6, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°04'30.9" N, 16°51'02.9" E; PUWG: X 358692, Y 349486
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	128 m above sea level
Landform:	slightly undulating plain; soil profile located in a lower position on the field, drained by ceramic pipes and deep ditch
Land use:	arable field (2026: wheat)
Parent materials:	Pleistocene loess-like sediments and glacial tills (colluvium?) on Miocene clays
Classification WRB2022:	Calcic Chernozem (Epiloamic, Endosiltic, Humic, Pachic, Stagnic, Geoabruptic*, Protovertic) * abrupt textural difference is too deep as for Planosols
Classification SGP6:	Czarna ziemia kalcikowa
Original agric. evaluation:	class RIVa, complex 8D gsp:i



Soil profile 07 description

Horizon SGP	Ap1	Ap2	2ABkcg	2Bkcg	3Bikg
Horizon WRB	Ap1	Ap2	2ABkcg	2Bkcg(l)	3Bikg
Depth, cm	0-30	30-50	50-62	62-98	98-140
Colour, moist	2.5Y 2/1	2.5Y 2/2	10YR 5/2	10YR 6/8	10YR 6/8
Boundary	gradual	gradual	gradual	clear wavy/irregular	-
Structure	granular/ blocky subangular fine	blocky angular/ subangular fine	blocky subangular fine	blocky angular/ subangular fine/medium	blocky angular medium
Consistence	friable	firm	firm	firm	very firm
Texture	L	L	SiL	SL	C
Skeleton	<5%	<5%	<5%	<5%	0
Carbonates	+ (lime)	(+)	++ fine nodulae	++ fine nodulae	++
Reductomorph. features	-	-	30%	50-70% 5GY 7/1	40% 5GY 7/1
Oximorphic features	-	-	30% 10YR 5/6	30-50%	60%
Redox accumulations	-	-	fine Mn masses	fine Mn masses	fine Mn masses
Clay accumul.	-	-	-	-	-
Slickensides	-	-	-	-	+
Earthworm channels/coasts	++	++	+	+	-
Other	-	-	-	-	ceramic drain at 110 cm
Diagnostics	chernic	chernic	stagnic protocalcic	stagnic (+ gleyic?)* calcic	stagnic protocalcic protovertic

* Note criterion 5 of the stagnic properties (WRB 2022).

Analytical data for soil profile 07

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	< 0.002	sand	silt	clay	
		%	%									%			
Ap1	0-30	<5	0.7	2.8	7	8.5	10	25	17	4	25	29	46	25	L
Ap2	-50	<5	0.8	3.5	7.7	7	11	24	16	6	24	30	46	24	L
2ABkcg	-62	<5	1	2.5	4.5	4	8	32	19	7	22	20	58	22	SiL
2Bkcg	-98	<5	1.5	3	7	6.5	9	29	16	7	21	27	52	21	SiL
3Bikg	-140	0	0	1.3	1.8	2.9	6	12	15	8	53	12	35	53	C

Explanation: L – loam (glina zwykła), SiL* – silt loam (pył ilasty), C – clay (ił zwykły)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-30	1.44	1.93	0.14	14	0	7.6	6.9
Ap2	-50	1.66	1.41	0.09	17	0	7.6	7.0
2ABkcg	-62	-	0.89	0.07	14	11	7.9	7.3
2Bkcg	-98	1.62	0.49	0.03	-	18	8.1	7.5
3Bikg	-140	1.5	0.23	0.01	-	10	8.0	7.0

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-30	0	0	22.2	1.45	0.72	0.06	24.4	24.4	18.2	100	100	100
Ap2	-50	0	0	23.9	1.63	0.33	0.06	25.9	25.9	19.3	100	100	100
2ABkcg	-62	0	0	45.6	1.90	0.19	0.09	47.8	47.8	13.3	100	100	100
2Bkcg	-98	0	0	45.6	1.81	0.12	0.09	47.6	47.6	9.1	100	100	100
3Bikg	-140	0	0	39.7	5.99	0.26	0.15	46.1	46.1	25.8	100	100	100

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V = S \cdot 100 / T$, **eBS** – effective base saturation $sBS = S \cdot 100 / S + Al^{3+}$, **BS** – ‘real’ base saturation $BS = S \cdot 100 / CEC$

SOIL PROFILE 08

Localization:	Kębłowice, 5/132, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°04'40.1" N, 16°51'05.5" E; PUWG: X 358975, Y 349548
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	131 m above sea level
Landform:	slightly undulating plain; soil profile located in a higher, flat section of the field
Land use:	arable (2026: phacelia)
Parent materials:	Pleistocene glacial tills on glaciofluvial sands
Classification WRB2022:	Endoskeletal Brunic Phaeozem (Epiloamic, Katoarenic, Amphiraptic, Bathyglyeyic)
Classification SGP6:	Gleba szara typowa (rdzawa, średnio głęboko gruntowo-glejowa)
Original agric. evaluation:	[[class RIIIb, complex 2D gsp:i]]



Soil profile 08 description

Horizon SGP	Ap1	Ap2	2ABv	2BvC	3C	4Cgg
Horizon WRB	Ap1	Ap2	2ABw	2BwC	3C	4Cl
Depth, cm	0-20	20-38	38-50	50-65	65-80	80-150
Colour, moist	10YR 3/2	10YR 3/2	10YR 4/3	10YR 5/3	10YR 6/2-3	10YR 7/2
Boundary	gradual	gradual	gradual	clear wavy	clear wavy	-
Structure	granular/ blocky subangular fine	blocky subangular fine	blocky subangular fine	single grain	single grain	single grain
Consistence	very friable	friable	very friable	loose	loose	loose
Texture	SL	SL	LS	LS	S	S
Skeleton	<5%	<5%	15% fine gravel	0	60% fine/very fine gravel	0
Carbonates	-	-	-	-	-	-
Reductomorph. features	-	-	-	-	-	-
Oximorphic features	-	-	-	-	-	5-25% 10YR 6/6
Redox accumulations	-	-	-	-	-	-
Clay accumul.	-	-	-	-	-	-
Slickensides	-	-	-	-	-	-
Earthworm channels/coasts	++	++	+	+	-	-
Other	-	-	-	-	-	-
Diagnostics	mollic	mollic	(brunic)	(brunic)	stagnic	gleyic

Analytical data for soil profile 08

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	< 0.002	sand	silt	clay	
		%	%									%			
Ap1	0-20	<5	7.5	22.5	17	10	6	16	8	2	11	63	26	11	SL
Ap2	-38	<5	10	24	17	10	4	16	6	3	9	65	25	9	SL
2ABv	-50	15	18	34	20	9	3	8	2	1	5	84	11	5	LS
2BvC	-65	<5	11	35	22	8	8	10	1	1	4	84	12	4	LS
3C	-80	60	35	40	11	2	4	4	1	1	2	92	6	2	S
4Cgg	-150	0	4	37	47	7	1	1	1	1	1	96	3	1	S

Explanation: SL – sandy loam (głina piaszczysta), LS – loamy sand (piasek gliniasty), S* – sand (piasek luźny)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-20	1.69	0.78	0.08	10	0	6.0	4.7
Ap2	-38	-	0.85	0.08	11	0	5.8	4.5
2ABv	-50	1.84	0.36	0.02	16	0	6.2	5.1
2BvC	-65	1.68	0.16	0.01	14	0	6.4	5.2
3C	-80	-	0.10	0.01	-	0	6.7	5.6
4Cgg	-150	1.71	0.06	0.01	-	0	6.9	6.6

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pH_{KCl}** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-20	2.15	0	1.48	0.14	0.18	0.00	1.79	3.94	3.20	45	100	56
Ap2	-38	1.76	0	1.45	0.14	0.21	0.03	1.82	3.58	3.21	51	100	57
2ABv	-50	0.36	0	1.15	0.11	0.11	0.03	1.39	1.75	1.92	79	100	72
2BvC	-65	0.10	0	0.95	0.11	0.05	0.01	1.11	1.21	1.29	92	100	86
3C	-80	0.05	0	0.82	0.11	0.05	0.01	0.99	1.04	1.15	95	100	86
4Cgg	-150	0.05	0	0.75	0.11	0.04	0.01	0.91	0.96	0.94	95	100	97

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** – Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** – extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $eBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

SOIL PROFILE 06

Localization:	Jarząbkowice, 17/1, Kostomłoty municipality, Środa Śląska county, Lower Silesia voivodshaft
Coordinates:	51°05'53.3" N, 16°45'45.5" E; PUWG: X 361418, Y 343392
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	132 m above sea level
Landform:	undulating plain; soil profile located in a lower position on the field, drained by ditch
Land use:	arable field (2026: buckwheat)
Parent materials:	Pleistocene loess-like sediments on glaciofluvial sands
Classification WRB2022:	Luvic Stagnic Chernic Phaeozem (Anosiltic, Humic, Pachic, Endoraptic, Solimovic?, Relictiturbic?)
Classification SGP6:	czarna ziemia (wyługowana) iluwialna
Original agric. evaluation:	class RII, complex 1D gsp



Soil profile 08 description

Horizon SGP	Ap1	Ap2	Ap3	ABg	Btg	2Cgg	2Cg
Horizon WRB	Ap1	Ap2	Ap3	ABg	Btg	2Cl	2Cg
Depth, cm	0-18	18-40	40-55	55-70	70-85	85-100	100-150
Colour, moist	10YR 2/1	10YR 2/1	10YR 2/1	10YR 3/2	10YR 4/2	10YR 5/2	10YR 5/6
Boundary	clear smooth	clear smooth	gradual	gradual	clear wavy	gradual	-
Structure	granular medium	blocky angular/subangular fine	blocky angular fine	blocky angular/subangular fine	blocky angular fine	single grain	single grain
Consistence	very friable	firm	friable	friable	friable	loose	loose
Texture	SiL	SiL	SiL	SiL	SiL	SL	S
Skeleton	<5%	<5%	<5%	<5%	<5%	0	0
Carbonates	-	-	-	-	(+)	-	-
Reductomorph. features	-	-	-	10% 10YR 5/2	10% 10YR 5/2	80%	25% 10YR 5/2
Oximorphic features	-	-	-	-	80%	20% 10YR 6/6	75%
Redox accumulations	-	-	-	very fine Mn masses	very fine Mn masses	fine Mn masses	-
Clay accumul.	-	-	-	(coatings)	coatings	-	-
Slickensides	-	-	-	-	-	-	-
Earthworm channels/coasts	++	++	++	+	+	-	-
Other	-	-	-	-	-	-	-
Diagnostics	chernic	chernic	chernic	-	argic stagnic	gleyic* (turbic)	stagnic

* Note criterion 5 of the stagnic properties (WRB 2022).

Analytical data for soil profile 06

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	< 0.002	sand	silt	clay	
		%	%									%			
Ap1	0-18	<5	1	3	10	5	11	28	22	12	8	30	62	8	SiL
Ap2	-40	<5	1	2	9	7	9	26	24	9	13	28	59	13	SiL*
Ap3	-55	<5	1.5	4.5	11	9	8	23	19	9	15	34	51	15	SiL*
ABg	-70	<5	1.5	3.5	7	9	7	26	21	4	21	28	51	21	SiL*
Btg	-85	<5	0	0	2	4	11	34	18	5	26	17	57	26	SiL*
2Cgg	-100	0	0	0	2	64	12	9	2	1	10	78	12	10	SL
2Cg	-150	0	0	0	2	79	10	4	0	1	4	91	5	4	S

Explanation: SiL – silt loam (pył gliniasty), SiL* – silt loam (pył ilasty), SL – sandy loam (głina piaszczysta), LS – loamy sand (piasek gliniasty)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ap1	0-18	1.51	1.96	0.16	13	0	6.4	5.5
Ap2	-40	1.55	1.31	0.09	14	0	6.3	5.4
Ap3	-55	1.6	1.08	0.06	17	0	6.5	5.5
ABg	-70	1.61	0.77	0.05	17	0	6.8	5.7
Btg	-85	1.73	0.40	0.03	-	tr.	7.6	6.6
2Cgg	-100	-	0.24	0.02	-	0	7.6	6.6
2Cg	-150	1.53	0.14	0.01	-	0	7.8	6.8

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ap1	0-18	1.58	0	8.3	1.12	0.54	0.03	10.0	11.6	17.1	86	100	58
Ap2	-40	1.88	0	7.7	0.94	0.17	0.04	8.9	10.8	15.0	83	100	59
Ap3	-55	0.76	0	7.6	0.90	0.10	0.03	8.6	9.4	12.5	92	100	69
ABg	-70	0.46	0	7.7	0.93	0.13	0.05	8.8	9.3	11.6	95	100	76
Btg	-85	0	0	11.6	1.89	0.19	0.07	13.7	13.7	13.2	100	100	100
2Cgg	-100	0.2	0	2.8	0.36	0.05	0.01	3.2	3.4	3.3	94	100	99
2Cg	-150	0.1	0	1.0	0.26	0.03	0.01	1.3	1.4	1.4	93	100	96

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** - Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** - extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V = S \cdot 100 / T$, **eBS** – effective base saturation $eBS = S \cdot 100 / S + Al^{3+}$, **BS** – ‘real’ base saturation $BS = S \cdot 100 / CEC$

SOIL PROFILE 09

Localization: Kąty Wrocławskie, 2551, Kąty Wrocławskie municipality, Wrocław county, Lower Silesia voivodshaft

Coordinates: 51°00'48.8" N, 16°45'09.8" E; PUWG: X 352039, Y 342416

Physiographical units: Silesian Lowland, Wrocław Plain

Altitude: 144 m above sea level

Landform: undulating plain; soil profile located in a concave basin/valley drained by ditches

Land use: in the past: meadow; presently afforested

Parent materials: Pleistocene loess-like sediments (colluvium?) on Miocene clays

Classification WRB2022: Eutric Vertic Chernic Planosol (Anosiltic, Endoclayic, Humic, Geoabruptic, Solimovic?, Uterquic?)
or
Eutric Endostagnic Chernic Gleysol (Anosiltic, Endoclayic, Geoabruptic, Humic, Solimovic?)

Classification SGP6: czarna ziemia wylugowana wertikowa

Original agric. evaluation: class -, complex LsF gcp:i



Soil profile 09 description

Horizon SGP	Ah1	Ah2	Ahgg	A/G	2Big
Horizon WRB	Ah1	Ah2	Ahl	A/Cr	2Big
Depth, cm	0-12	12-30	30-46	46-70	70-100
Colour, moist	10YR 2/2	10YR 2/2	2.5Y 1/1	5Y 6/1	7.5YR 5/8
Boundary	gradual	clear wavy	clear irregular	abrupt/clear wavy	-
Structure	granular fine/medium	blocky subangular fine	blocky angular fine	blocky angular/subangular fine	blocky angular /wedge
Consistence	very friable	friable	firm	firm	very firm
Texture	SiL	SiL	SiL	SiL	CL
Skeleton	0	0	0	10% remains of pavement	0
Carbonates	-	-	-	-	-
Reductomorph. features	-	-	matrix colour?	80%	45% 5GY 6-7/1
Oximorphic features	-	-	-	10% 7.5YR 5/8	45%
Redox accumulations	-	-	-	fine Mn masses	fine Mn masses
Clay accumul.	-	-	-	-	-
Slickensides	-	-	-	(+)	+
Earthworm channels/coasts	+	+	+	+	+
Other	-	-	-	-	vertical cracks
Diagnostics	chernic	chernic	chernic gleyic?	gleyic?*	stagnic vertic

* Note criterion 5 of the stagnic properties (WRB 2022).

Analytical data for soil profile 09

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	< 0.002	sand	silt	clay	
		%	%									%			
Ah1	0-12	<5	0	1	2	2	10	38	21	8	18	15	67	18	SiL*
Ah2	-30	0	0.3	1	1.3	1.4	7	34	25	7	23	11	66	23	SiL*
Ahgg	-46	5	0.3	1	1.5	2.2	7	32	23	7	26	12	62	26	SiL*
2A/G	-70	10	0	0	0	1	10	39	22	5	23	11	66	23	SiL*
2Big	-100	0	1	3	5	8	14	21	12	5	31	31	38	31	CL

Explanation: SiL* – silt loam (pył ilasty), CL – clay loam (głina ilasta)

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl
		g cm ⁻³	%			%		
Ah1	0-12	-	3.22	0.24	13	0	5.4	4.6
Ah2	-30	1.05	1.81	0.12	15	0	5.3	4.4
Ahgg	-46	1.40	1.44	0.08	18	0	6.0	5.0
2A/G	-70	1.56	0.33	0.03	-	0	6.5	5.3
2Big	-100	1.59	0.24	0.03	-	0	6.2	5.0

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pHw** – pH in distilled water (1:2.5 v/v), **pHkcl** – pH in 1 M KCl (1:2.5 v/v)

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Ah1	0-12	6.4	1.5	10.4	2.46	0.42	0.06	13.3	19.7	24.9	68	90	54
Ah2	-30	7.2	1.3	9.9	2.42	0.22	0.08	12.6	19.8	20.0	64	91	63
Ahgg	-46	2.8	0.2	12.3	3.52	0.27	0.15	16.2	19.0	25.6	85	99	64
2A/G	-70	1.4	0	6.1	1.87	0.21	0.13	8.3	9.7	13.3	86	100	62
2Big	-100	0.46	0	9.2	3.04	0.27	0.19	12.7	13.1	20.6	96	100	62

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** – Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** – extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V=S*100/T$, **eBS** – effective base saturation $sBS=S*100/S+Al^{3+}$, **BS** – ‘real’ base saturation $BS=S*100/CEC$

SOIL PROFILE 11

Localization:	Wrocław - Żerniki, 79, Wrocław municipality, Wrocław county, Lower Silesia voivodshaft
Coordinates:	51°07'43.3" N, 16°55'46.5" E; PUWG: X 364473, Y 355172
Physiographical units:	Silesian Lowland, Wrocław Plain
Altitude:	116 m above sea level
Landform:	slightly undulating plain; soil profile located in a low flat position drained by ditches
Land use:	in the past: arable fields; presently: fallow; mainly goldenrod (<i>Solidago canadensis</i> L.)
Parent materials:	Pleistocene loess-like sediments (colluvium?) on lacustrine and fluvial (?) sediments
Classification WRB2022:	Calcaric Chernic Gleysol (Episiltic, Katoloamic, Aric, Drainic, Humic, Limnic?, Raptic)
Classification SGP6:	czarna ziemia podmokła (murszowata?)
Original agric. evaluation:	class ŁIII, complex 2zM ms:pl/5D pgm:pl



Soil profile 11 description

Horizon SGP	Aphca	Apcagg	2A/Lgg	3G
Horizon WRB	Apha	Apal	2A/BCrλ	3Cr
Depth, cm	0-30(35)	30-46	46-60	60-100
Colour, moist	10YR 2/1	2.5Y 1/1	7.5Y 4/4	10GY 4/1
Boundary	abrupt wavy	abrupt wavy/irregular	clear smooth	-
Structure	granular medium/coarse	blocky angular fine/medium	massive	blocky angular /massive
Consistence	friable	firm	(plastic)	firm
Texture	SiL	SiL	SL	SL
Skeleton	0	0	0	0
Carbonates	++	+	-	-
Reductomorph. features	-	matrix colour?	60%	90%
Oximorphic features	-	-	40% 7.5YR 5/6 (around root channels)	10% 7.5YR 4-5/6-8 (around root channels)
Redox accumulations	-	-	-	fine Fe masses
Clay accumul.	-	-	-	-
Slickensides	-	-	-	-
Earthworm channels/coasts	+	+	-	-
Other	-	-	jarosite?	H ₂ S smell
Diagnostics	chernic calcaric	chernic	thionic? gleyic	gleyic

Analytical data for soil profile 11

Horizon	Depth cm	Skeleton	Sand fractions					Silt fractions			Clay	Sum			Class
		>2 mm	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002	sand	silt	clay	
		%	%									%			
Aph	0-28	0	2	5	9	14	7	31	23	5	4	37	59	4	SiL
Ap _{gg}	-47	0	1	2	11	15	15	37	10	4	5	44	51	5	SiL
2LG	-60	0	1	1	5	26	23	26	12	2	4	56	40	4	SL
3G1	-80	0	1	2	12	19	22	30	11	1	2	56	42	2	SL
3G2	-100	0	0.5	0.5	1	4	25	50	15	2	2	31	67	2	SiL

Horizon	Depth cm	BD	SOC	N	C:N	CaCO ₃ eq.	pHw	pHkcl	EC	S _{xrf}
		g cm ⁻³	%			%			dS/m	
Aph	0-28	-	5.90	0.477	12	32	7.8	7.4	0.49	2870
Ap _{gg}	-47	-	3.24	0.176	18	0 / (tr.)	5.0	4.7	2.35	8400
2LG	-60	-	0.64	0.048	13	0	3.0	2.7	3.09	3200
3G1	-80	-	0.48	0.031	-	0	3.0	2.8	3.53	6300
3G2	-100	-	1.42	0.100	-	0	3.3	3.2	3.29	4300

Explanation: **BD** – bulk density, **SOC** – soil organic carbon, **N** – total nitrogen, **pH_w** – pH in distilled water (1:2.5 v/v), **pH_{kcl}** – pH in 1 M KCl (1:2.5 v/v), **EC** – electric conductivity (1:2.5 v/v), **S_{xrf}** – total sulphur, mg/kg

Horizon	Depth cm	Kh	Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	S	T	CEC	V	eBS	BS
		cmol kg ⁻¹									%		
Aph	0-28	-	-	70.0	2.48	0.32	0.18	73.0	-	51.8	-	-	100
Ap _{gg}	-47	-	-	54.4	1.57	0.14	0.23	86.3	-	50.2	-	-	100
2LG	-60	-	-	11.1	1.05	0.09	0.16	12.4	-	11.3	-	-	100
3G1	-80	-	-	6.1	1.24	0.11	0.07	7.5	-	13.9	-	-	54
3G2	-100	-	-	9.5	2.00	0.17	0.13	11.8	-	11.9	-	-	99

Explanation: **Kh** – hydrolytic acidity, **Al³⁺** – Al extracted by 1 M KCl, **Ca²⁺**, **Mg²⁺**, **K⁺**, **Na⁺** – extracted by 1 M ammonium acetate buffered at pH 7, **S** – sum of cations (Ca+Mg+K+Na), **T** – ‘extractable’ cation exchange capacity (S+Kh), **CEC** – ‘real’ cation exchange capacity (extracted by 1 M ammonium acetate buffered at pH 7), **V** – base saturation $V = S \cdot 100 / T$, **eBS** – effective base saturation $sBS = S \cdot 100 / S + Al^{3+}$, **BS** – ‘real’ base saturation $BS = S \cdot 100 / CEC$

