

THE IDENTIFICATION OF THE LEAD WHITE IN THE MEDIAEVAL POLISH PAINTING OF THE SCHOOL OF GDAŃSK POMERANIA BY MEANS OF INAA

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ABSTRACT

The materials research is important part of the technological studies of the panel paintings. The development and continuous perfecting of ultrasensitive instrumental techniques in the analytical chemistry makes possible the realization more and more detailed and precise analyses. In research of the painting with the large success used is neutron activation analysis among other things to the determination of trace elements in the lead white. The purity of lead white is directly related with the development of methods of production and purification of lead. The variation seen in trace element compositions according to region and time, proper authentication would require compiling a library of analyses of carefully documented paintings with which to compare statistically the painting in question. Such work can confidently contribute to the reassignment of dates and the placement of objects in their correct historical context. The present work targets the performance of findings of the lead white proceeding from of chosen panel paintings from the Basilica Our Lady in Gdańsk being with the representative example late Middle Ages of the painting of Northern Poland. The systematical research of the lead white in the Polish painting of the epoch of Middle Ages let on the creation of the database concerning concentrations of trace elements in lead white of the leaded school Silesian and of Little Poland what lets on the exhibition of the Pomeranian school against the background of other workshops. On this base exists the possibility of the proof of interrelationships or to separating the guild of different each paint shops working in different regions of Poland. Additionally for the comparison will become represented findings of West-European panel paintings being found in Polish collections: the Dutch painting represents the Triptych The Last Judgment by Hans Memling (nowadays - the National Museum in Gdańsk), and German school represents the painting from the former main altar of the church St. Elisabeth in Wrocław painted by Hans Pleydenwurff (nowadays - National Museum in Warsaw).

INTRODUCTION

In the second half of the XV century, Gdańsk enjoyed renown as one the most significant cities of Europe. The city belonged to Hanzeatic League and operated extensive trading activities. Its favorable economic condition promoted the development of the city. The rich society founded both sacred and secular buildings decorated with numerous works of art [1].

Being a significant commercial centre, Gdańsk maintained wide contacts with a number of cities Europe-wide. The Gdańsk art of those times was particularly influenced by the Netherlands and Northern Germany [2].

The largest and the most significant shrine in the city was the Blessed Virgin Mary's Basilica.

The Blessed Virgin Mary's Basilica was an expression of the city's power in its religious, social and cultural aspects.

Under these circumstances, wealthy families, fraternities and craft guilds were undertaking efforts to show their significance by funding expensive works of art for the church. In addition to a number of other works of art, numerous altar decorations in the form of triptychs or extended polyptychs used to be exposed in the church.

Gdańsk panel painting of the second half of XV century is a non-homogeneous combination works of art. A part of the altars might have been imported, while another was created by foreign artists working in Gdańsk or by local painters.

Therefore, the paintings from the Blessed Virgin Mary's Basilica constitute a representative collection of the Pomeranian painting [3].

The study covered 16 paintings originating from old altar decorations preserved in their entirety or part.

Additionally, West-European paintings of known origins, such as: the Netherlandish triptych *Last Judgment* (dated 1467-1479) by Hans Memling (1435-1494) present in St. Mary's Basilica in Gdańsk since 1473, currently in the collection of the National Museum in Gdańsk [4] and fragments of a plot from the old altar in the St. Elisabeth Church in Wrocław [5] (1462) illustrating *Offering of Jesus in the Shrine*, by Hans Pleydenwurff (1420 – 1472), a German painter, currently in the National Museum in Warsaw, have been selected for comparison.

Identification of materials plays an important role in studying works of art. Recognition of specific features of materials allows for supplementing the knowledge on their nature, origins, the region in which a given work was created as well as preferred techniques. Instrumental neutron activation analysis (INAA) has been successfully applied in studies of old painting. The method is used for assaying trace elements contained in lead white. The pigment was a predominant type of white paint used by painters from antiquity up to XIX century.

The purity of lead white is directly related to the development of methods for production and purification of lead. Except for the technological process, distribution of trace elements depends on the origins of lead ore deposits.

Therefore, results of assaying trace elements in lead white by means of neutron activation analysis are helpful in determining the time when a painting was created as well as any later restorations and allow for obtaining additional information on the origins of a painting. The neutron activation analysis is helpful both in dating a work as well as in identifying any repainting or conservation activities. Based on currently available analytical results, two types of white lead have been identified: the so-called trans-Alpine white used in paintings to the North of the Alps and cis-Alpine white applied in the South, mainly in Italy.

EXPERIMENTAL

All the samples were taken from paintings subjected to a routine maintenance work after revealing their structure and state of preservation of the original layers. After removal of protective coating with a scalpel under a microscope a sample of the white was taken directly to a quartz ampoule. The sampling spots were selected so that they had not shown admixtures of other pigments as indicated by UV luminescence tests. Detailed description of the paintings is presented in the Table 1. 1-6 samples from each object, with a mass from 0.1 to 1 mg were collected.

The analysis of lead white samples was carried out using the INAA method without chemical separation, using standards of analysed elements. The samples were packed together with standards of such elements as Na, K, Sc, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb,

Sr, Zr, Mo, Ru, Ag, Cd, Sn, Sb, Te, Cs, Ba, La, Ce, Pr, Nd, Sm, Eu, Tb, Dy, Ho, Er, Yb, Lu, Hf, Ta, W, Ir, Au, Hg, Th and ²³⁸U. Also attached were the standards of Au and Sc evaporated onto a piece of aluminium foil. They played the role of the thermal neutron flux monitor.

Catalogue and sample number	Name of panel painting	Dating
Gdansk School		
1P-25 ÷ 29	<i>The Mary Retable of Priestly Guild</i> , The Church of the Blessed Virgin Mary, Gdańsk	1473-1478
2P -17 ÷ 18	<i>The predella with Martyrdrom of St. Adrian</i> , The Church of the Blessed Virgin Mary, Gdańsk	after 1468
3P -12 ÷ 14	<i>The large of Ferbers Altar</i> , The Church of the Blessed Virgin Mary, Gdańsk	1480-1498
4P - 6÷7; 9÷10	<i>The small of Ferbers Altar</i> , The Church of the Blessed Virgin Mary, Gdańsk	1485-1490
5P - 48 ÷ 53	<i>The Jerusalem Triptych</i> , The Church of the Blessed Virgin Mary, Gdańsk	1490-1500
6P - 30 ÷ 35	<i>The Triptych of Crucifixion</i> , The Church of the Blessed Virgin Mary, Gdańsk	1480-1500
7P-15 ÷ 16	<i>The predella with life of Mary Virgin</i> ,The Church of the Blessed Virgin Mary, Gdańsk	1485-1490
8P- 20 ÷ 21	<i>The Table of Ten Commandments</i> , The Church of the Blessed Virgin Mary, Gdańsk	1480-1490
9P- 4 ÷ 5	<i>The Saviour Christ</i> on the doors of ciborium , The Church of the Blessed Virgin Mary, Gdańsk	1478/-1482
10P - 39÷42	<i>The Retable of St. Simon and St. Thaddeus</i> , The Church of the Blessed Virgin Mary, Gdańsk	1485-1490
11P - 43÷47	<i>The Retable of St. Barbara</i> , The Church of the Blessed Virgin Mary, Gdańsk	1480-1500
12P- 36	<i>Ecce Homo</i> , The Church of the Blessed Virgin Mary, Gdańsk	1483-1500
13P - 28, 29	<i>The Flagellation and Thorn Crown</i> , The Church of the Blessed Virgin Mary, Gdańsk	after 1487
14P - 22÷24	<i>The predella of Mary Virgin with the Child</i> , The Church of the Blessed Virgin Mary, Gdańsk	after 1478
15P - 19	<i>The predella of Mary Virgin Coronation</i> , The Church of the Blessed Virgin Mary, Gdańsk	2 nd half 15 th century
16P - 37, 38	<i>The predella of Christ and the 12 Apostles</i> , The Church of the Blessed Virgin Mary, Gdańsk	about 1500
Malopolska school		
M-1	<i>Adoration of Dead Christ</i> , Chomranice	1438-1439
M-2	<i>Triptych</i> , Kamionka Mala	1456
M-3	<i>St. Catherine of Alexandria</i> , Biecz	1470
M-4	<i>Mourning over Dead Christ</i> , Czarny Potok	1449
M-5	<i>Triptych</i> , Nowy Sacz	1452
M-6	<i>Triptych</i> , Ptazkowa	1440
Silesian School		
S1- 7, 21	<i>Crucifixion Triptych</i> , Gac Slaska	1440-1450
S-2	<i>St. Barbara's Altarpiece</i> , Wroclaw	1447
S-3	<i>Veraikon</i> , Wroclaw	1460
S-4	<i>Veraikon</i> , Legnica	1450
S-5	<i>Crucifixion Triptych – Peter Wartenberg's Foundation</i> , Wroclaw	1468
S-6	<i>Werder's Epitaph</i> , Wroclaw	1456
S-7	<i>Triptych of St. Hedwig's Legend</i> , Wroclaw	1440
S8- 17	<i>The Virgin and Child</i> , Wroclaw	1460
S8- 23	<i>St. James's Life</i> , Wroclaw	1460
S-9	<i>The Virgin in Apartment</i> , Wroclaw	1460-1465
S-10	<i>The Polyptych from St. Elisabeth Church</i> , Wroclaw	1482
S-11	<i>Andrzej Steinberg's Epitaph</i> , Swidnica	1486/87
S-12	<i>The Retable from St. Peter and St. Paul Church</i> , Strzegom	1486/87
S-13	<i>Dolorous Christ from St Elisabeth Church</i> , Wroclaw	1486/87
S-14	<i>Prince W. Zaganski's Epitaph</i> , Wroclaw	1486/87
S-15	<i>The Retable from The Blessed Virgin Mary Church, Wroclaw na Piasku</i>	1486/87
German and Netherlands School		
G-14	<i>Hans Pleydenwurff - the Retable from St Elisabeth Church</i> , Wroclaw	1462
D - 61 ÷ 64	<i>Hans Memling – The Last Judgment</i>	1473

Table 1. Description of the analysed samples

Irradiation of the samples was carried out in MARIA reactor in Świerk, in the channel with $8 \cdot 10^{13}$ n/cm²s thermal neutron flux. The irradiation time was 24 hours with subsequent 8-hour cooling. Then the irradiated samples were unpacked and washed in 1:1 hydrochloric acid solution and rinsed in alcohol to remove surface contaminations.

Measurements of activity of samples and standards prepared in such way were carried out using HP germanium detector with active volume of 80 cm³ and energy resolving power of 1.95 keV for 1333 keV - ⁶⁰Co energy. The detector cooperates with S100 Canberra analyser, controlled by IBM/PS-2. The analysis of complex gamma radiation spectra was carried out using micro-SAMPO and Gene 2000 programmes. The measurements were repeated six times within three months after irradiation. The measurement time varied between 300 and 10000 seconds.

ANALYSIS RESULTS

Forty elements were identified and determined in analysed samples. Various methods of statistical analysis were used to evaluate whether these differences are related to using different input materials or result from errors during the analysis (non-representative sample collected). Additionally, only distributions of the elements that are important in lead white identification were analysed [6,7].

Out of 40 determined elements, only the elements identified in all tested samples were selected for further analysis. Elements such as Cd, Ga, Ho, Lu, Mo, Ni, Rb, Se, Tb, Ta and Zr, the content of which in a majority of analysed samples, was below the method detection threshold, were disregarded.

The clustering analysis using STATISTICA (StatSoft) programme [6] was carried out to identify the similarity degree of analysed objects. The clustering analysis was carried out for standardised and logarithmic variables.

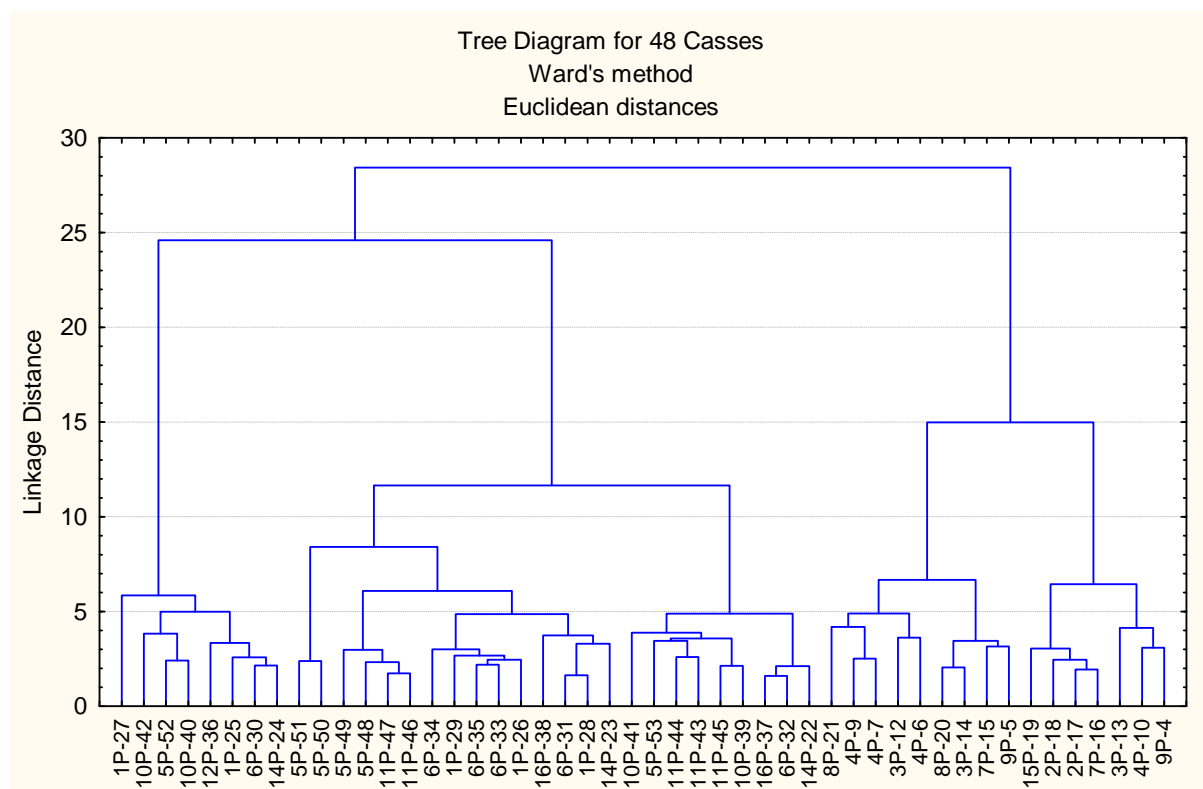


Fig. 1. Cluster analysis of 16 analysed panel paintings Pomeranian school describes 28 features (features number = determined elements number); standardised and logarithmic variables

A cluster analysis procedure was first applied, using all the variables for all tested 48 samples of lead white collected from 16 paintings represented Pomeranian school. Ultimately, 28 elements were selected for multi-parameter statistical analysis aimed at identifying the degree of similarity of analysed paintings. The output dendrogram is shown in Figure 1. The studies have proven that lead white used in Gdańsk paintings is similar to the trans-Alpine white used in Northern Europe. Its characteristic features are low contents of silver and zinc. The pigment that has been used for painting was pure, which is a testimony of its very good quality. The analysis of clusters from samples of the Pomeranian School paintings has allowed for dividing them into four groups. Such a division suggests that lead ores originating from various sources were used for the production of lead white.

As compared to other Polish schools – that of Malopolska [6] and Silesian [7], the Pomeranian painting brings resemblances to the Silesian school. Figure 2 presents results of this analysis.

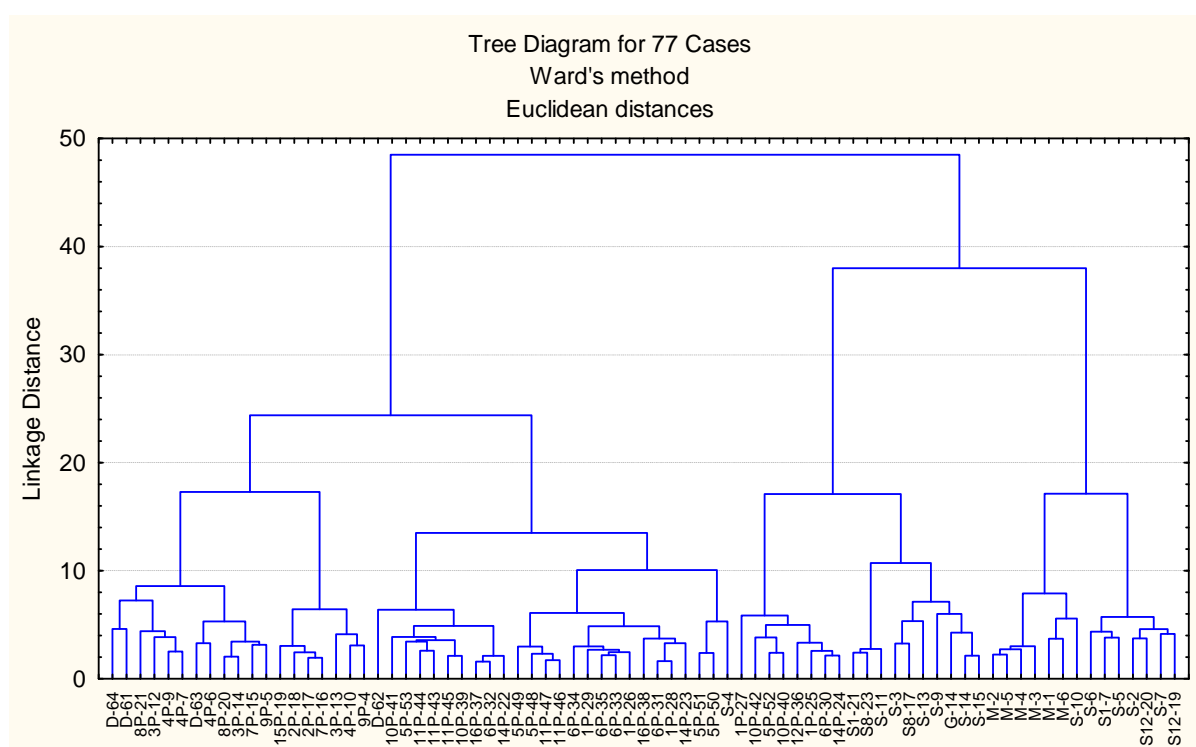


Fig.2. Cluster analysis of 16 analysed icons, 22 lead white samples taking from panel paintings of Malopolska and Silesian Schools and 2 samples represented German and Netherlands schools describes 28 features (features number = determined elements number); standardised variables

There are distinct differences with respect to the Malopolska school of painting. They prove that sources of white lead were different. Contrary to the Malopolska school, the Pomeranian school represents a non-homogeneous set. Moreover, the Malopolska school is distinguished by high amounts of copper and silver that are present at sustained level almost in all analyzed objects.

Taking into account the results of clustering analysis, the range of concentrations (minimums and maximums) of trace elements (Ag, As, Ce, Cu, Eu, La, Sb, Sm and Zn), very important in lead white identification, was determined. Figure 3 presents distributions of these elements in analysed lead white samples from Malopolska, Silesian and Pomeranian schools.

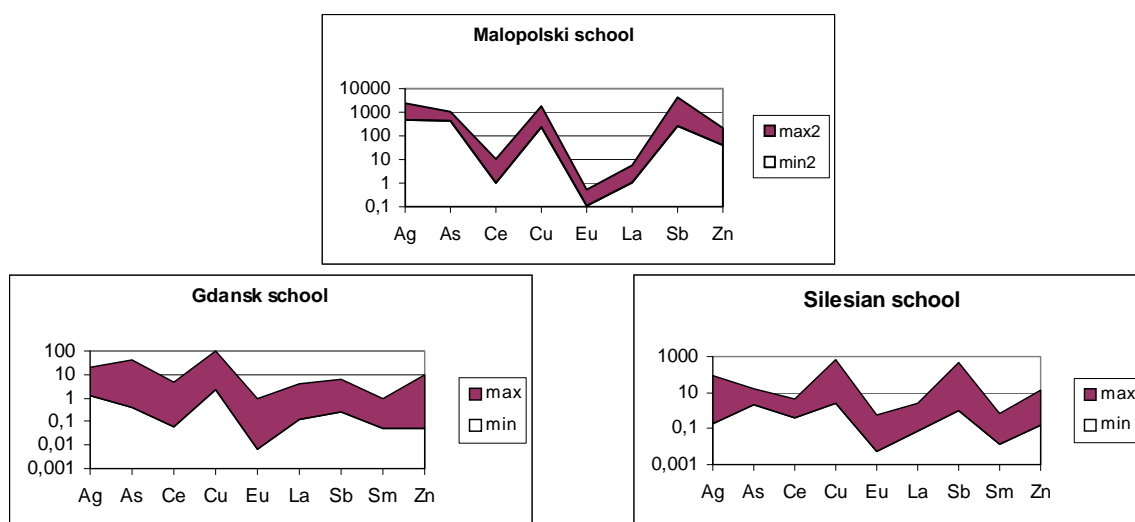


Fig. 3. Trace element patterns in lead white from Gdansk, Malopolska and Silesian schools paintings

CONCLUSIONS

The geographical location of Gdańsk, its wide contacts and trade exchange created favourable conditions for acquiring high quality materials. The white lead identified in the Pomeranian paintings shows distinguishable similarities to the white applied by Hans Memling, who worked in the Netherlands and works by Pleydenwurff, the German artist, who worked for the St. Elisabeth Church in Wrocław. That fact may prove that the methods used for the production of white lead were similar and provides information on the supply sources of painting materials associated with the tradition of Western and Northern Europe. The Malopolska school is more closely related to the tradition of Polish art. Lead ores were probably acquired from domestic deposits from mines in the regions of Malopolska, Silesia or the Świętokrzyskie Mountains.

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CHOSEN THE EXAMPLE OF STUDIED PAINTINGS



Photo 1. The small of Ferbers Altar, Pomeranian school, (end of 15th century), the Blessed Virgin Mary Basilica, Gdansk (photo A. Skowroński)



Photo 2. The retable from St. Peter and St. Paul Church, Strzegom, Silesian school, (end of 15th century) (photo A. Skowroński)



Photo. 3. Hans Memling, The Last Judgment, Netherlands school, (end of 15th century), National Museum in Gdansk (photo A. Skowroński)



Photo 4. Hans Pleydenwurff, The Christ Offertory in Shrine, German school, (end of 15th century) the National Museum in Warsaw (photo W. Grzesik)

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