Doctoral dissertation: *"Arsenic Compounds in Icon Painting. An Analysis of the Phenomenon Based on a Group of Icons at the National Museum in Cracow"*

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Summary

The leitmotif of the doctoral dissertation *"Arsenic Compounds in Icon Painting – an Analysis of the Phenomenon Based on a Group of Icons at the National Museum in Cracow"* comprises nine 15th- and 16th-century icons. Set against other pieces forming part of the collection and dating back to the same period, they are distinct in the presence of arsenic compounds in smoothly painted background and nimbus sections. Yet the hue of these surfaces astonishes. The expected yellow or orange-red associated with the most popular and oldest arsenic pigments (orpiment and realgar) has been replaced with a grey-cream shade of white. It was that detail which had led me to a quest for analogies in reference literature – and an analysis of materials potentially usable in rendering surfaces mentioned herein. Keen on tracing degradation processes, I performed ageing tests on samples I prepared and painted myself, studying the orpiment discolouration rate under assorted factor exposure. The natural and forced degradation outcomes for the painted layers I applied were then recorded in element decomposition mapping, with the use of an X-ray fluorescence macro-scanner (MA-XRF). Ultimately, all activities seem to be confirming that nine of the 15th- and 16th-century icons from the Cracow collection have lost their originally intended artistic expression as a result of arsenic pigments applied in realisations having degraded. The icons' artistic expression has thus strayed far both from the authors' intentions and iconographic canon guidelines. Furthermore, an analysis of instrumental research publications with a focus on multiple icon paintings from southern and northern Europe alike allows me to conclude that in terms of technology, the aforementioned nine icons are closest to artworks of the Pskov and Novgorod schools. Yet at this research stage, one would be hard-pressed to conclude whether artists had been using imported or domestic pigments. To quote Anna Różycka-Bryzek, *"Sourced in local minerals, the colour palette typical for the Pskov school of painting made it distinctly different to that of Novgorod; bereft of the pure and joyful hues the Novgorodians were so fond of, it was somewhat*

morose and dramatic with its dense greens combined with varied browns, against invariably dark blue backgrounds"[1]. Consequently, the question regarding orpiment sources remains open.

The issues of orpiment and realgar decomposition I am exploring herein are equally significant from an art conservator's perspective. Knowledge of orpiment and realgar degradation mechanisms and resulting secondary minerals – arsenic oxides in particular – is essential to the safety of objects as well as experts responsible for their conservation, as these oxides are as poisonous as the commonly known arsenic. Moreover, the sensitivity of arsenic pigments to light makes objects containing them particularly vulnerable; in consequence, they require as much protective care as fabric or paper, a factor of key importance to the process of drafting respective exhibition and storage guidelines.

The textual volume of this work totals 278 pages. It is accompanied by 69 pages of illustrations and photos. It includes eight chapters and an annex with maps, photographs and visualisations, affording better comprehension of each section. The dissertation contains information from a variety of fields: art history, painting technology, chemistry, mineralogy and mining, and history of painting material trade. Orpiment and realgar have clearly been pervasive, chiefly as yellow- and red-hued dyes. Exceptions include orpiment found in 15th- and 16th-century icons of Northern Ruthenia, used to cover vast background surfaces and nimbi with intent to emulate goldleaf.

In the first chapter, I focused on listing locations where orpiment- and realgar-containing paintings have been found, all objects presented in chronological order, ancient Egypt to the 17th century.

In the second chapter, I described the purposes of aforesaid arsenic pigments, as specified in reference sources and painting treatises.

In the third chapter, I portrayed the technological structure of icon paintings, referencing the theology of the icon as well as its individual technological layers.

The above theme has been developed in the fourth chapter, which explores the function and purpose of the orpiment and realgar in Coptic, Greek, Balkan and Ruthenian icons, as well as those originating from the Polish-Ukrainian borderland. I arranged all aforesaid pigments

[1] Anna Różycka-Bryzek, *Bizantyńsko-ruskie malowidła w kaplicy Świętokrzyskiej na Wawelu* (*Byzantine Ruthenian Paintings in the Holy Cross Chapel of the Wawel Castle*), *Studia do dziejów Wawelu* (*Studies for the History of the Wawel Castle*), ed. Jerzy Szablowski, Adam Bochnak, vol. 3, *National Art Collections at the Wawel Castle*, Cracow 1968, p. 218.

according to their share in the colour palette – reds, oranges, browns, and greens (occasionally blues) – their importance to skin hues duly emphasised. I approached orpiment separately as a goldleaf substitute. In all analyses, I referenced icons created over the period coinciding with that of the pivotal icons of Cracow. Arsenic pigments – orpiment and realgar – and their degradation mechanisms were my primary focus. Yet a multitude of other natural (yellow and red) arsenic sulphides can be identified in the overall arsenic pigment array, such as dimorphite, pararealgar, alacranite, anorpiment, duranusite, uzonite, wakabayashilite and bonazziite, not to mention synthetic forms of both orpiment and realgar.

I presented their entire group in the fifth chapter, pointing to differences in their structure (stratigraphic or cage-based), colour, and chemical properties.

In the sixth chapter, I focused on orpiment and realgar degradation mechanisms in the context of their chemical instability. Once exposed to intense lighting, high humidity, or ozone-rich environs, both convert into arsenic oxides, resulting in discolouration on painting surfaces and change to technological layer interiors.

In the seventh chapter, I referenced techniques and technologies associated with nine 15th- and 16th-century icons pivotal to the dissertation. I also described the way of producing painted samples: I used natural orpiment obtained from ground mineral and historical Kremer pigments, bound with four adhesives (binders). The chapter includes ageing test outcomes after ca. 1.5 years of observing painting strata in samples, which displayed discolouration identical to that found in the backgrounds and nimbi of referenced icons. This has served to confirmed earlier hypotheses regarding orpiment use in background and nimbus sections.

In the eighth and final chapter I consider a supplement, I explored issues concerning the sources and distribution of orpiment and realgar in the Mediterranean in the 15th and 16th century. Since antiquity, the vast majority of these pigments had been sourced on the Persian and Anatolian Plateaus. Only two European locations where both could be found were known: the Kozjak Mountains in northern Macedonia, and the neighbourhood of Tajov, Slovakia. It is, however, notable, that Europe had been connected to the Middle East and Africa with a network of efficient trade routes (over land and sea) when the icons of Cracow were in the making. These routes were chiefly active owing to Venetians and Genoese, later also Germans and the Dutch, in all likelihood also Armenians trading in Levantine goods in the East (Black Sea to Lviv). It is thus probable that if not sourced nearby, arsenic pigments applied in the icons of Cracow were imported from the Middle East.

In view of the aforementioned backgrounds and nimbi, the Pskov-related provenance of the nine 15th- and 16th-centiury icons described herein seems to be highly probable. As Anna Różycka-Bryzek wrote, artists from faraway Pskov, whose oeuvre had been truly flourishing since mid-15th century, were also active in Cracow, paintings in the Holy Cross Chapel of the Wawel Castle indeed attributed to them[2]. It is therefore possible that they had been working across Przemyśl lands as well. The use of orpiment in backgrounds in paintings on wood was also referenced in a replica of a 1618 Armenian manuscript (*MS arménien 186*, BnF, Paris)[3]. Yet the connection between icons of Pskov and Armenian paintings would require further archival research.

[2] Różycka-Bryzek, op. cit., pp. 218-220.
[3] Raymond H. Kévorkian, Armèn. Ter-Stépanian, *Manuscrits arméniens de la Bibliothčque nationale de France: Catalogue, Paris*, (*MS arménien* 186), *Bibliotheque nationale France*, Paris, 1998, pp. 722-726.