PAINTINGS

Questions of color: A technical study into Franz Marc's masterpiece *Grazing Horses IV (The Red Horses)* 

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### ABSTRACT

Franz Marc's pivotal work, *Grazing Horses IV*, has recently undergone a technical study at the Harvard Art Museums. The significance of the painting extends beyond its place in Marc's oeuvre due to its wider influence on German Expres-

# **INTRODUCTION**

I started with a very big painting depicting three horses in a landscape, full of color from one corner to the other, the horses arranged in a triangle. The colors are difficult to describe. For the foreground, pure vermillion alongside pure cadmium and cobalt blue, deep green and carmine, the horses ranging from yellowish brown to violet. A very imposing, emphatically modeled setting; whole stretches of it (e.g. a bush) in the purest blue! Can you even imagine that? All the shapes astonishingly strong and clear so that they'll be able to support the colors.

The starting point of this investigation was the letter quoted above (Marc 2007, 2 February 1911), complete with a compositional sketch that Franz Marc sent to his future wife in early 1911, describing the colors and composition of *Grazing Horses IV* (Figure 2). This paper aims first to determine whether the pigments present are consistent with those mentioned by Marc, and secondly to establish what evidence there is for the development of the composition on the canvas. The results of the composition analysis are presented, before attending to the questions of color.



**Figure 1.** *Grazing Horses IV*, 1911. Oil on canvas, 121 × 183 cm, Harvard Art Museums/ Busch-Reisinger Museum (2014.301), Bequest in memory of Paul E. and Gabriele B. Geier. Image: President and Fellows of Harvard College

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sionism, but despite the extensive art historical discourse on his work, little technical analysis has been published to date. This investigation aimed to establish his materials and methods, from preparatory processes through to varnish application. The findings revealed a strong correlation between the material evidence of the painting's composition and palette, and documentary sources describing his theories on artistic realization. This study has recorded the purposeful development of his style, and underlined the significance of this painting as a turning point in his oeuvre. With this particular painting, Marc found his characteristic style of depicting animals using strong forms with powerful colors.



**Figure 2.** Detail of Marc's letter to Maria Franck written in old German Kurrent. Image: von Holst (2000, 83)



**Figure 3.** Top and bottom pinhole in the center of *Grazing Horses IV* 

# Investigation techniques

The imaging methods used were visible light (normal, raking, reflected), ultraviolet (UV) fluorescence, infrared digital photography (IRDP), and x-radiography. Pigment identification was carried out with polarized light microscopy (PLM), x-ray fluorescence spectroscopy (XRF), scanning electron microscopy with energy-dispersive x-ray spectroscopy (SEM/EDS), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, high-performance liquid chromatography-mass spectrometry (HPLC-MS), and pyrolysis-gas chromatography/mass spectrometry (py-GC/MS).<sup>1</sup>

## Subject, composition, and pentimenti

*Grazing Horses IV* is the fourth and largest canvas in a series of similar compositions completed in 1910, the year before Franz Marc finished the here discussed masterpiece. The first two versions have a naturalistic palette, while the third is painted with more intense shades with colorful highlights in the landscape. Another version, *Horse in a Landscape*, has a blue-maned, chestnut horse set against a bright yellow field, and shows evidence of the pure colors that have come to characterize *Grazing Horses IV*. Two preparatory tempera studies on paper, *Horses at Pasture I* and *II*, are further examples of his progressive forays into color. Viewed chronologically, these works reveal Marc as adding more and more color to each subsequent version and demonstrate the development of his individual color language, an expressive means to "heighten the essence of the depicted" (Lankheit 1976).

Additionally, the tempera studies provide evidence of the development of his compositional structure; both works contain fine pencil lines, mapping out the triangle mentioned and sketched by Marc in his letter. They lead diagonally from the corners to cross in the middle. Infrared examination of Grazing Horses IV revealed a similar short line running diagonally through the center, matching those present in the sketch and studies. At the center of the painting two small holes 5.9 centimeters apart were pricked into the fresh paint, and appear to be related to the scaling up of the composition from the sketches, as well as working out distances and proportions, presumably by using a pin with an attached string (Figure 3).<sup>2</sup> The left hole is positioned in the exact middle of the painting, and matches the cross point of the diagonals in the tempera sketches, while the right hole is aligned with the slightly shifted triangle in the sketch in the letter. It is likely that when Marc began planning the composition he chose the center of the papers, and subsequently the canvas, but later adjusted the 'center' point to balance the composition.

Pentimenti in *Grazing Horses IV* suggest that though Marc remained initially faithful to the preparatory studies, he made numerous changes directly on the canvas. The most pronounced compositional change relates to the form of the right horse: alterations to the abdomen and the rear left leg are visible with the naked eye, and IR and x-radiography revealed that the rear right leg was initially painted unbent, whereas in the final version the leg is slightly bent, and shifted to the right (Figure 4).

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**Figure 4.** Detail of the reworked right horse (vis, IRDP, raking light, x-ray)



Figure 5. Detail of the landscape (vis, UV)

The changes made to the color of the horses during the painting process are considered to be the most significant. Instead of the 'yellowish brown to violet' colors mentioned in the letter, the left horse has been painted in a fiery red, with the right horse slightly more orange-red, and the middle horse with a crimson to wine-red body, with yellowish brown hues. The manes of all three horses range from blue and violet, to a very dark purple. The middle appears the most similar color to that described in the letter, and it is likely that all three horses were initially painted in this hue. The previously described re-working of the right horse, combined with a strikingly thicker paint of the outer horses and the visible traces of the crimson color in their contours, support this hypothesis.

These aspects trace Marc's development of his color-rich style over the course of his preparation for this painting, but it was not until the paint was on the canvas of *Grazing Horses IV*, that he abandoned the more naturalistic 'yellowish-brown to violet', for the powerful hues of the present horses. This major decision affected the composition's balance, and necessitated the adjustment of some compositional details and color fields.

# Marc's palette, layer build-up, and development of color

Considering Marc's documented profound and careful deliberations over color, and his intentions relating to the impression of color and surface, one would assume that his selection of pigments was similarly weighted. The analytical results indeed largely support this assessment, identifying the colorants listed in his letter. For the foreground, the pure vermillion alongside pure cadmium, which refers to yellow, and the cobalt blue he mentioned, were all confirmed in this area. The deep green was determined to be viridian. The 'purest blue' of the bush was synthetic ultramarine partly mixed with cobalt blue, and passages were lightened by adding lead white.

In addition to the pigments listed in the letter, the following findings were also made: the two outer horses were mainly painted with vermillion, mixed with cadmium yellow and likely cadmium orange. The horses' blazes were executed with lead white, and the right horse's mane contains mainly cobalt violet. The yellow areas underneath the left horse contain cadmium and strontium yellow, and the sky was executed with cadmium yellow and lead white. The ground layer is chalk-based, with small amounts of zinc white and traces of lead white. White appears to have been used extensively throughout the painting to shift areas of the landscape from intense hues to pastel shades; toning down the landscape in this way has increased the intensity of the horses.

There are different red lake pigments present in *Grazing Horses IV*, of which two were classified more precisely. These are located adjacently in the pink-colored areas in the landscape on the upper-left hill.<sup>3</sup> One exhibited a bright orange fluorescence under UV illumination (Figure 5). HP-LC-MS of a sample from this fluorescent region detected a high level of pseudopurpurin, some purpurin, but no alizarin, and no constituents of other lakes or dyes, such as carminic acid. This combination suggested a processed form of madder, and precluded the use of synthetic alizarin, which does not contain purpurin or pseudopurpurin (Kirby, Spring, and Higgitt 2007). The German-French chemist Emil Kopp (1817–1875)

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**Figure 6.** Cross section no. 1, green foreground beneath blue bush at left edge



**Figure 7.** Early drying cracks with oozing paint taking close to cross section 1 (top). Yellow area beneath the left horse, assuming to be oil- and gum-bound (bottom)

developed a processing method involving sulfuric acid for natural madder which results in a colorant with similar properties to that identified here (Kopp 1864). Elemental analysis (SEM/EDS) showed the substrate had high levels of aluminum and sulfur with low to trace amounts of potassium and phosphorous, consistent with Kopp's purpurin; however, the particles were too small for conclusive analysis (Schweppe and Winter 1997). Kopp's purpurin served as the colorant for oil colors named purpurin madder lake, pink madder or rose madder, and was widely used in the second half of the 19th and early 20th century (Kirby, Spring, and Higgitt 2007). The presence of Kopp's purpurin is significant as it has not previously been reported on a Marc painting.<sup>4</sup>

There are also distinct, non-fluorescing particles of an intense red lake pigment present. It has an aluminum and phosphorous substrate. This elemental information, the visual appearance and absence of fluorescence have analogy with a carmine lake, an insect-derived dyestuff from cochineal, kermes, or lac. In contrast to cochineal and kermes, lac lakes reputedly do not fluoresce (Eastaugh et al. 2004). Aside from the aforementioned hill, this color also appears to be the predominant colorant for the middle horse. A scraping sample for HP-LC-MS is under investigation to clarify the presence of carmine.

No pure black color was used.<sup>5</sup> The darkest passages of the painting, such as the eyes of the horses, were mixtures of intensely colored pigments. While Marc did use black paint in other works (Pfandlbauer 2013), this absence of pure black is in line with his scientific understanding of light and color at the time, especially refraction of light into spectral colors through a prism (Klingsöhr-Leroy 2005).

A letter from Marc to his friend and colleague August Macke sheds light on his complicated paint build-up and its relationship with optics (Marc 2007, 14 February 1911). Marc looked through prisms during the painting process and describes a layering relating to spectral colors. He saw 'most terrific rings of colors', apparently a key aspect of his painting technique. Instead of having sharp delineating borders, the different shades of colors he used for this layering are often still visible at the junctions of the adjacent fields. Cross sections also confirm this multilayered and multicolored construction, exemplarily demonstrated in cross section no. 1 (Figure 6), containing the following pigments (inferred from SEM/EDS, bottom-up): layer 1) calcium carbonate (CaCO<sub>2</sub>) and zinc white (ZnO); layer 2) red lake wash (orange UV fluorescence); layer 3) cobalt blue (CoO·Al<sub>2</sub>O<sub>2</sub>), a red lake (orange UV fluorescence) and possibly cobalt violet  $(Co_3(PO_4)_2)$ ; layer 4) vermilion (HgS); layer 5) cadmium yellow (CdS), strontium yellow (SrCrO<sub>4</sub>), and possibly a lake suggested by the presence of Al and P; layer 6) a chromium green, likely viridian ( $Cr_2O_2 \cdot 2H_2O$ ). Layer 7 shows a crack where the orange paint layer oozes upwards, like described below and demonstrated in Figure 7.

The initial elemental analysis using XRF was complicated by this complex structure, and was exacerbated by the presence of an unfinished, rejected composition on the verso (von Hedenström and Roth 2016).<sup>6</sup> Due to this complexity of the layers, and the quantity of colors, not every pigment

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Color	Pigment and method	Formula, comments
white ground	calcium carbonate <sup>2,3,4</sup>	CaCO <sub>3</sub>
	gypsum <sup>2,3,4</sup>	CaSO <sub>4</sub>
white	lead white <sup>1,2,3,4</sup>	(PbCO <sub>3</sub> ) <sub>2</sub> • <b>Pb(OH)</b> <sub>2</sub>
	zinc white <sup>1</sup>	ZnO
red	vermillion <sup>1,2,4</sup>	HgS
	iron oxide red <sup>3</sup>	Fe <sub>2</sub> O <sub>3</sub>
orange	cadmium orange <sup>1,2</sup>	CdS(Se)
yellow	cadmium yellow <sup>1,2</sup>	CdS
	strontium yellow <sup>1,2,4,6</sup>	SrCrO <sub>4</sub>
	chrome yellow <sup>2</sup>	PbCrO <sub>4</sub>
green	viridian <sup>2,6</sup>	Cr <sub>2</sub> O <sub>3</sub> ·2H <sub>2</sub> O
blue	cobalt blue <sup>1,2</sup>	CoO·Al <sub>2</sub> O <sub>3</sub>
	synthetic ultramarine <sup>2,3,4</sup>	3Na2O·3Al2O3·6SiO2·5Na2S
violet/pink	1 <sup>st</sup> organic lake <sup>2,5,7</sup>	most likely Kopp's purpurin
	2 <sup>nd</sup> organic lake <sup>2,7</sup>	possibly carmine
	3 <sup>rd</sup> organic lake <sup>2,7</sup>	likely madder
	cobalt violet <sup>1</sup>	Co <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>
	manganese violet <sup>1</sup>	$(NH_4)_2Mn_2(P_2O_7)_2$
	ah a v a a a 18	carbon based

Table 1. Pigment identification

<sup>4</sup> = Raman; <sup>8</sup> = microscopy/morphology

# Varnishing technique

 $^{6} = PLM;$ 

<sup>7</sup> = UV;

5 = HP-LC-MS;

Additional to his use of color to balance the composition, Marc often used a subtler visual modifier, that of partial varnishing, to direct the viewing experience. A review of his oeuvre revealed an inconsistency in his varnishing approach; although some paintings have an overall coating, he seemed to renounce this more traditional application in favor of unvarnished or partially varnished surfaces. It enabled a dialogue to be established between the saturated, shiny areas and the unvarnished, duller surfaces.

*Grazing Horses IV* has a very uneven, old, natural resin varnish layer, which is most likely mastic or dammar. It appears selectively applied to highlight particular areas, such as parts of the landscape and the horses' manes, while many other passages, like the sky and the distant landscape, were left uncoated.<sup>8</sup> As far as analysis can tell, this natural resin varnish is artist applied. A cross section from the yellow region beneath the left horse shows no natural varnish present, nor evidence of a former varnish removal, while other cross sections reveal a varnish application incorporated into the fresh paint (described more below).

# Binders and manipulation of paint

Art historical evidence and comparison to other works strongly suggested that while Marc used available commercial artists' products, he manipulated their

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QUESTIONS OF COLOR: A TECHNICAL STUDY INTO FRANZ MARC'S MASTERPIECE GRAZING HORSES IV (THE RED HORSES) visual and handling properties with a variety of additives (Pohlmann 2006) – not an uncommon practice. Other paintings by Marc have been observed to contain aqueous components in his binding media (Hofmeister 1991, Pohlmann 2006). In a 1912 letter to Gabriele Münter, Marc recommended his personal diluent recipe of copaiba balm, copaiba oil, elemi resin, mastic and turpentine (Marc 2007, 1 January 1911). The use of such materials may have contributed to the early-drying cracks often found in Marc paintings (Figure 7). Non-oily components were detected in the binder of *Grazing Horses IV*; FTIR identified gum and wax in the yellow region beneath the left horse. Under UV illumination, several cross sections exhibited areas of a natural resin-like fluorescence, demonstrating that Marc incorporated glazing layers with a high proportion of natural resin into the paint (Figure 8).



Figure 8. Cross section no. 2 in visible light and UV illumination

A second observed degradation behavior is the oozing of an orange paint through the drying cracks and into overlying paint layers. This phenomenon can be seen over the entire painting where this orange is used in a lower layer. Py-GC/MS detected di- and triterpenoids in the orange paint, which includes copaiba, elemi, mastic, and dammar resins. The source of the specific resins could not be identified as characteristic marker ions were not detected, but clearly Marc modified or layered the paint in a way that caused it to crack and allowed underlying paint to extrude, as demonstrated in cross section 2.

An additional theory is that the orange paint was formulated with resinous material, likely copaiba balm, a common inclusion in industrially prepared oil paints in Germany in the 19th and early 20th century, although this was known to increase paint sensitivity to solvents (Pohlmann 2006, Poggendorf 2015). Several studies have observed that resins in paint layers can be easily reactivated with solvents, causing migration of pigments in upper layers through gradual liquefaction of the paint (Schmitt 2012, Poggendorf 2015).

# CONCLUSION

This technical investigation has established a critical baseline of material evidence for the study of Marc's materials and techniques, which can be used to inform future analyses of works from his oeuvre, and those of other German Expressionists. The presence of the pinholes, pentimenti, and the changing color of the horses highlighted Marc's efforts to create a perfectly balanced composition. The extent of these changes across the canvas is revealed in the multilayered build-up of color, and his manipulation of light through selective varnishing.

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QUESTIONS OF COLOR: A TECHNICAL STUDY INTO FRANZ MARC'S MASTERPIECE GRAZING HORSES IV (THE RED HORSES) The examination of this painting in the context of Marc's correspondence has revealed correlations between what was written, and what is present, and has revealed insights into his development of the composition and use of color. These findings reinforce the painting's position as a major stylistic turning point in his oeuvre.

The presence of any kind of resin, artist-incorporated or industrially formulated, should generally be considered at a Marc painting as well as paintings around that time in general. Such materials make paint vulnerable to damage and can make certain conservation treatments complicated to impossible: without knowing exactly what is present, the risk of disrupting the paint layer during a varnish removal is very high. Future research on Marc's oeuvre should focus on the identification of additives in the paint to facilitate the ongoing care and treatments of his works.

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# NOTES

- <sup>1</sup> SEM/EDS and HP-LC-MS were carried out at the Museum of Fine Arts, Boston.
- <sup>2</sup> The use of pinholes, often at the vanishing point, to transfer, scale up and generally work out a composition is a widely known practice, and has been documented in works stretching from Vermeer (Wadum 1995) to Kandinsky, as in *Red Spot II*, 1921.
- <sup>3</sup> Very similar properties under UV illumination were observed in other Marc paintings from the same period, including *Small Blue Horses*, 1911, and *Small Yellow Horses*, 1912.
- <sup>4</sup> Other works by Marc have been observed to exhibit similar fluorescence; identification of this colorant may be limited in these cases by sampling restrictions and/or instrument access.
- <sup>5</sup> Only a few very isolated carbon black particles are present in cross –sections; these might be associated with the preparation process.
- <sup>6</sup> An image of the verso is available online: www.harvardartmuseums.org/collections/ object/222353?q=2014.301.
- <sup>7</sup> Samples were predominantly taken from the perimeter, which is hidden by the rebate of the frame.
- <sup>8</sup> An additional, overall, modern synthetic varnish was applied during a past conservation treatment prior to acquisition. The painting's surface now has a more homogenous, glossy appearance that reduces Marc's intended surface variation. Unfortunately, cleaning tests revealed an extreme sensitivity of the paint layers to a wide range of solvents that makes removal of the modern varnish layer complicated, and potentially impossible, due to the risk of disrupting the paint layers.

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