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A Reexamination of the Pigment-Reinforcement Hypothesis of the Turin Shroud's Bloodstains

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ABSTRACT

New studies based on X-Ray photographs of the Turin Shroud (TS) from 1978 and new quantitative tests induced the author to reexamine the viability of a hypothesis he had discussed in a prior work [1] where he stated that “*A possible explanation for the presence of blood and pigments in the samples studied is that the bloodstains were originally produced by human blood which faded with time ... (and) have been reinforced by artists in the past centuries.*” In fact, the new quantitative results exclude red ochre/iron oxide and vermilion/mercuric sulfide as being responsible for the redness of the stains of blood that are visible with the naked eye on the TS. Having ascertained this result, two problems now arise. First, the origin of the additional reddish material found in correspondence with the TS bloodstains needs an explanation. A hypothesis to be confirmed is that the over 50 documented painted copies of the Relic made in past centuries may have deposited some pigment when they were pressed onto the TS, to be sanctified into higher order relics. The second problem concerns the explanation of the continued redness of the TS bloodstains. In addition to the hypothesis regarding the effects of ultraviolet rays on the high bilirubin content in the bloodstains on the TS and of the presence of carboxyhemoglobin, the author considers the redness of blood coming from an alleged Eucharistic Miracle.

Keywords: Turin Shroud, Sticky tapes, Bloodstains, Human blood, Sub-micron particles, Red ochre, Cinnabar, X-Ray

1. INTRODUCTION

We have seen in Ref. [1] that the Turin Shroud, (TS) [2-8] is a handmade 3:1 twill linen cloth, 4.4 m long and 1.1 m wide, on which the front and back images of a human body are permanently and mysteriously imprinted. According to the Catholic Christian tradition, the TS is the burial cloth in which Jesus Christ was wrapped before being placed in a tomb in Palestine about 2000 years ago. The Catholic Christian Church does not impose any veneration requirements of the TS, even though Science has been unable to refute what is reported by tradition. There are some indications that the TS was in Palestine in the first century A.D., and then taken to Edessa (present-day Sanliurfa in Turkey). The coincidence of the TS face with that of Christ on Byzantine coins starting from the VII century A.D. is evidence that the TS was seen during the Byzantine empire. The “Shroud of Christ” then appeared in Europe in 1353 in Lirey in France after the Sack of Constantinople in 1204. In 1532, a fire damaged it at Chambéry in France. In 1988, the TS was radiocarbon-dated to 1260–1390 A.D. [9], but the result is questionable [10-13]. As the process that formed the body image is still unknown, the dating method cannot be rigorously applied, because the environment in which the object under analysis was conserved must be known from a contamination point of view. The imaging mechanism may, in fact, have varied the percentage of carbon isotopes of the TS, thus producing a non-negligible systematic effect. Many hypotheses have been formulated [5] to explain the double body image that is, so far, impossible to reproduce.

Regarding the numerous red stains present on the TS, various researchers examined them: W. McCrone [14-20], P.L. Baima Bollone [21], J. Heller and A. Adler of STuRP (Shroud of Turin Research Project) [22, 23] as well as others [24-26].

J. Heller and A. Adler detected the presence of primate blood on the TS, whereas, P.L. Baima Bollone, independently, detected the presence of human blood on the TS. In sharp contrast, and with the same samples as STuRP, W. McCrone detected no blood whatsoever on the TS, but, instead, he identified very small-sized red pigments (like red ochre and vermilion) which he named “Sub-Micron Particles” (SMP) as being the source of the red images on the TS. A dispute arose concerning the identification of what constituted the redness that is visible on the TS, but there has been no meeting of the minds between these two, starkly contrasted beliefs [27]. The objective of the prior paper [1] was to try and clarify this dispute and to propose a new interpretation of the data which reconciles primarily the findings of W. McCrone with those of J. Heller, A. Adler and P. L. Baima Bollone regarding the source of the redness on the TS. That new interpretation hypothesized that the bloodstains had been reinforced in the past with red pigments.

After the results from the new studies and tests, this paper reexamines the aforementioned interpretation [1]. In particular, it shows the insufficiency of pigments that had been hypothesized in Ref. [1] to evidence a visible image on the TS, basing both on the X-Ray photos described in [28] and on experiments born from the results detected in Ref. [29]. A discussion of these results concludes with the presentation of an alternative hypothesis.

2. REASONS FOR RECONSIDERING THE PAPER

Ref. [1] concludes: “... *Samples furnished by STERA Inc., labeled as 1HB and 3EF, have been analyzed The study addressed the attention to the reddish particles contained in these*

sticky tapes that appear to be of many types, shape and sizes and are connected with the TS fibers or dispersed in the sticky tapes. Some of them correspond to the SMP recognized by W. McCrone in the form of red ochre (iron oxide) and vermilion (mercuric sulfide) while others, as described by many researchers, are of human blood. ... while the major part of the analyzed reddish particles are of blood, also pictorial pigments like red ochre (iron oxide) and vermilion (mercuric sulfide) are present. Blood can be detected in crusts ... very frail and easily fragmented. Iron oxide (Fe_2O_3 , red ochre) has been found in SMP having sizes between 0.2 and 1.0 micrometers on the flax fibers and dispersed in the sticky tapes. Also cinnabar (HgS , vermilion) has been found in the TS stained fibers."

Therefore, Ref. [1] detected blood and SMPs composed of iron oxide and cinnabar in the sticky tapes posed in contact with the TS, but did not focused on the different areal densities of these particles as they appear from the analysis of Figs 1, 2, 4 and 6-SM of the same Ref. [1]. The following hypothesis was formulated: "A possible explanation for the presence of blood and pigments in the samples studied is that the bloodstains were originally produced by human blood which faded with time because they became frail and broke with TS rolling and un-rolling. For this reason, these bloodstains have been reinforced by artists in the past centuries. These results ... must be obviously confirmed by future analyses."

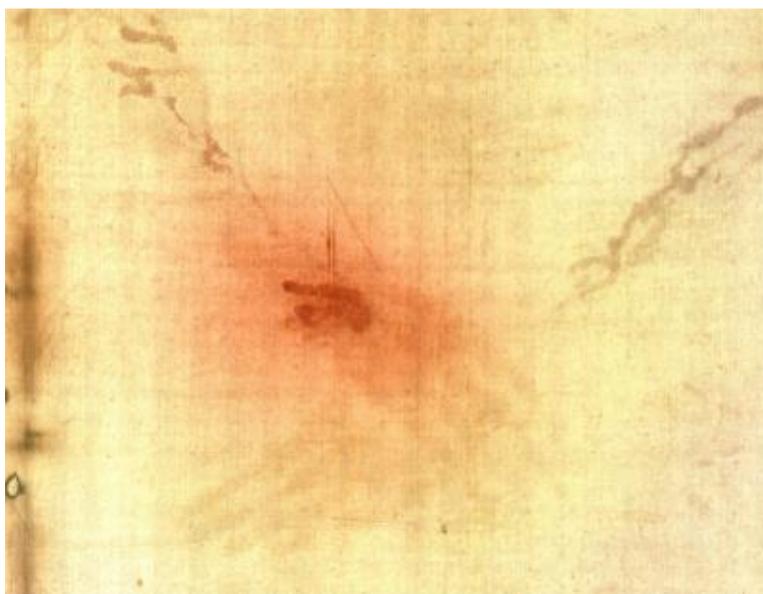


Figure 1. A reddish halo formed of microscopic particles of red pigments in the vicinity of the wrist wound on the TS should exist since if about 50 painted copies of the TS (which have red stains painted in different places), were put into direct contact with the Relic. Yet, no such contamination is visible to the naked eye and it was not even detected by X-Ray imaging.

The hypothesis of "blood reinforced by pigments" which appeared in Ref. [1] seemed the most reliable when compared to the alternative hypothesis based upon the possible contamination on the TS from having over 50 documented cases of authorized copies being sanctified by pressing them on the TS, from the 16th to the 18th century. Once painted, these copies were in fact made "relics by contact" by superimposing them on the TS and probably contaminating it with their pigments.

Since there is no correspondence in position between the bloodstains of the TS and the red stains of the painted copies of the TS (well evident if digital photos of painted copies are superimposed onto the same of the TS), this hypothesis was falsified because the copies should have produced a reddish halo around each bloodstain, see Fig. 1 that instead is not visible on the TS.

The following sections will present new data which challenges the hypothesis that the TS's bloodstains have been subsequently "*reinforced by pigments*" of Ref. [1] because, taken for granted that there is blood on the TS bloodstains, the pigments quantity present on the Relic seems insufficient to better highlight these red areas and therefore the hypothesized red halos too.

3. X-RAY PHOTOGRAPHY

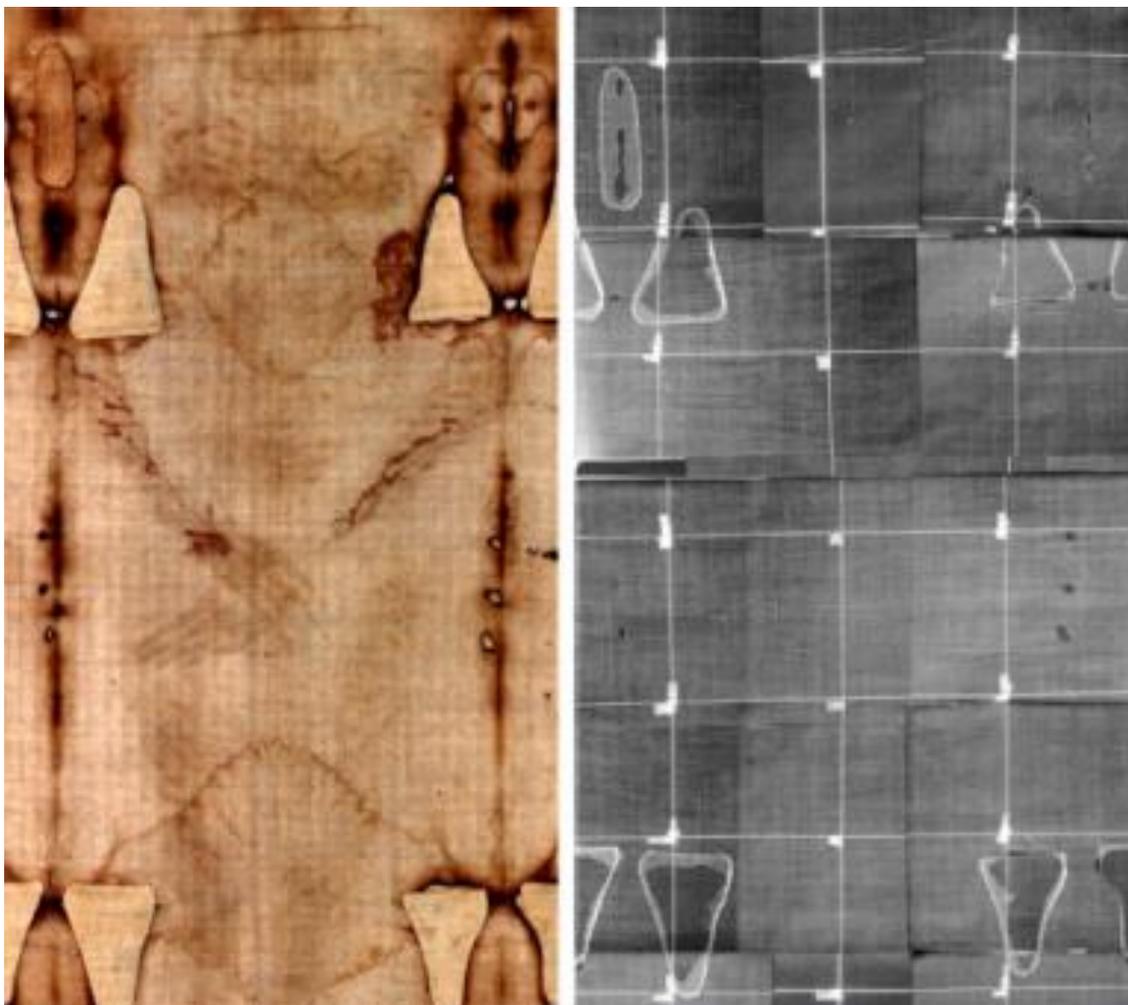


Figure 2. Mosaic of X-Ray photos of the TS on the right compared with the same areas of the TS photographed in visible light. The absence of details relative to body image and bloodstains in the X-Ray mosaic demonstrates that these details have not been painted with traditional pigments (©1978 William Mottern Collection, STERA, Inc.).

A substantial portion of STuRP's investigation of the TS revolved around whether or not it was a painting. As part of this specific query, STURP team members R.W. Mottern, R.J. London and R.A. Morris [28] had X-Ray photographs taken from the TS in order to detect the possible presence of elements having high atomic numbers (Z) like iron ($Z=26$) and mercury ($Z=80$), that are frequently used to make red pigments.

In order to discover whether or not iron oxide could be responsible for the red color of the bloodstains on the TS, they calibrated an X-Ray photographic system capable of detecting iron pigments (red ochre, Fe_2O_3) on the linen cloth having a thickness greater than 0.1 micrometers or having a density greater than 0.7 g/m^2 . The sensitivity of other materials - as the aforementioned STuRP authors declared - can be calculated based upon the information contained in Ref. [28].

Fig. 2 shows a mosaic, assembled by the author of this paper, corresponding to the central part of the ventral body image encompassing the chest wound, the bloodstain on the wrist, the scourge marks and other bloodstains alongside the arms. Additionally, some patches, scorch marks, waterstains and holes appear in this part of the TS. For comparison, the figure shows the same part of the TS image, but photographed in visible light to highlight the dissimilarities between the two photos. We see that, while patches, scorch marks, waterstains and holes also appear in the X-Ray mosaic, the bloodstains and body image are *not* visible. This, therefore, demonstrates the absence of a sufficient quantity of pigment necessary to show these details.

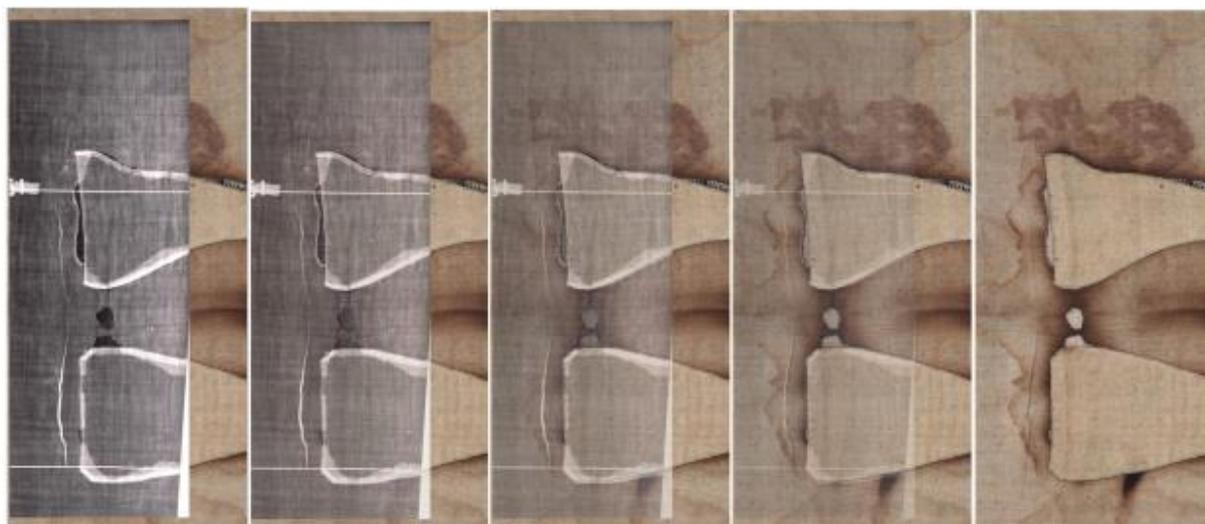


Figure 3. Different levels of superimposition of the X-Ray detail of the chest wound on the TS with the same portion of the TS photographed in visible light. (©1978 William Mottern Collection, STERA, Inc.).

In particular, Fig. 3 shows a partial superimposition of an X-Ray photograph of the chest wound (of Fig. 2 rotated 90°) with the same detail seen in visible light. While non-bloodstained areas show up on the X-Ray photo some details as the patches, the wrinkles in the cloth to the left of the patches, the holes between the patches and some signs of the water used to extinguish the Chambéry fire of 1532, the bloodstain of the chest wound is *absent* in the X-Ray photo. Therefore, the following deductions can be made.

- Both the body image and the bloodstains that are visible on the TS are not produced by pigments.
- If pigments or other substances having relatively high atomic numbers are present on the TS, their areal densities are insufficient to form the visible red image that can be observed on the bloodstains with the naked eye.

4. QUANTITATIVE X-RAY ANALYSIS

Two quantitative analyses based on X-Ray photographs were performed during the 1978 STuRP investigation. However, these results do not seem to have received, until now, the full attention they deserve. They are referenced here and discussed in light of the pigments which are discussed in Ref. [1].

4. 1. Quantitative X-Ray fluorescence of bloodstains

R. Morris et al. [29] performed quantitative X-Ray fluorescence analyses on some areas of the TS in an effort to determine whether or not elements with a relatively high atomic number (like iron and mercury) were present on the TS. An X-Ray detector was used on areas of 1.3 cm² of the TS which were illuminated by a tungsten target in order to detect iron pigments (Fe₂O₃) and other elements.

While they detected a practically uniform distribution of elements like calcium (about 2 g/m²) and strontium (about 0.02 g/m²) along the whole surface of the TS, they detected a concentration of iron higher than that of the whole TS surface, of about 0.1 g/m², in correspondence of the bloodstains with a maximum peak of 0.580 ± 0.029 g/m².

We can have an approximation of the areal density of iron in a human bloodstain if we perform the following rough evaluation. Experimental tests performed by the author show that one drop of blood having a volume $V_d = 0.02 \pm 0.01$ cm³ is required to impregnate one square centimeter of cloth like the TS with blood.

Knowing that an average man has 5000 ± 500 cm³ of blood, which contain 4000 ± 400 mg of iron, it turns out that the amount Q_i of iron in the blood is 0.8 ± 0.1 mg/cm³. Therefore, the areal density of iron D_i in a blood drop of a square centimeter due to the impregnation of human blood in a TS-like cloth is:

$$D_i = Q_i V_d = 0.8 \times 0.02 = 0.016 \pm 0.008 \text{ mg}$$

corresponding to a range of 8-24 µg/cm². This result can be compared with that of Ref. [27] which detected iron concentrations in the TS bloodstains in the range of 8-18 µg/cm² in the facial area, and maximum concentrations, respectively, of 50 µg/cm² at the chest wound and of 58 µg/cm² at the foot on the dorsal image.

The congruence of the experimental results with the bloodstain of the TS in the facial area should be observed, while the greater amount of iron found in the foot and chest wound of the TS suggests a more abundant flow of blood in those areas. We can therefore think that the bloodstains of the foot and of the chest wound probably formed as a result of the superimposition of multiple blood flows, perhaps occurring at different instants such as during the movement of the corpse.

The authors of Ref. [29] conclude: *“There appears to be no evidence of heavy element concentration differences between image (non-blood) and off-image points which would suggest an obvious forgery. ... Substantially non-uniform concentration of iron were observed, particularly at the dorsal-foot and side-wound ‘blood’ stain region. However we can say no more than either blood or some iron-based pigment was used to produce the stains”*.

This last inconclusive sentence, considering both the possibility that the TS red stains can be due to either blood or iron-pigments is discussed below.

4. 2. Quantitative photography of iron pigments

Ref. [1] detected the presence of both blood and iron oxide and mercuric sulfide; it was shown that Ref. [29] detected a maximum areal density of iron of $58 \mu\text{g}/\text{cm}^2$ at the bloodstain at the foot; X-Ray photography detected no images correlatable to iron in the X-Ray photos of Ref. [26], selecting a threshold of detectability for iron at $70 \mu\text{g}/\text{cm}^2$.

Iron pigments like ochre (Fe_2O_3) have significantly higher iron content than blood. Moreover, the source of blood’s red color comes from porphyrins within its hemoglobin content. Therefore, as the red stains on the TS are clearly visible and there is a relatively low iron density in these stains, this indicates that the redness visible on the TS with the naked eye is caused by the porphyrins in blood, not by iron pigments. To test this fact, the following experiment was performed.



Figure 4. Photo of the foot on the dorsal image of the TS onto which are superimposed for comparison a white fabric and the same white fabric colored with iron oxide having an areal density of iron of $58 \mu\text{g}/\text{cm}^2$.

Powdered red ochre was applied to a piece of white fabric so as to have an iron density of $58 \mu\text{g}/\text{cm}^2$. Assuming that all the powder is composed of iron oxide (Fe_2O_3) and knowing the atomic masses of oxygen (15.999 u) and iron (55.845 u) we obtain the following density for red ochre [$58 \mu\text{g}/\text{cm}^2 \times (15.999 \times 3 + 55.845 \times 2) / 55.845 \times 2 =$] $83 \mu\text{g}/\text{cm}^2$.

This amount of powder was spread onto the white fabric to detect the resulting reddish color. Figure 4 shows a piece of white fabric and a similar piece colored by the predefined quantity of red ochre, both superimposed to a detail of a copy of the TS showing the foot of the dorsal image.

While spectrum 18 of Ref [29] reports an iron concentration of only $16.5 \pm 2.3 \mu\text{g}/\text{cm}^2$ in correspondence with a well evident bloodstain of the hair, we see in Fig. 4 that $58 \mu\text{g}/\text{cm}^2$ is not sufficient in the experiment to reach a reddish color density similar to the TS bloodstains on the foot.

This result, therefore, demonstrates that, while relatively low areal densities of iron (about $16 \mu\text{g}/\text{cm}^2$) contained in human blood are sufficient to produce the well evident bloodstains visible on the TS, quantities more than 3.5 higher of iron contained in red ochre are not sufficient to produce the same effect on the TS.

5. DISCUSSION

We have seen renewed discussions and new data that have prompted a reexamination and reassessment of the hypothesis described in Ref. [1], because the pigments quantity present on the TS is insufficient to produce any of the redness (or any color whatsoever) that can be seen on the TS with the naked eye. The consequences of these new findings are discussed below.

5. 1. Negligible effects of the contact with painted copies

X-Ray photography and quantitative analysis [1] have shown that the detected SMP of iron oxide and mercuric sulfide can be reasonably excluded as the source of the red matter that is visible with the naked eye on the TS. Therefore, the hypothesized red halo of Fig. 1 around the bloodstains, produced by way of contact transfer from the painted copies of the TS being pressed against the Relic, would have to be invisible to the naked eye. However, if the hypothesis of the production of halos around the bloodstains discussed above is not verified, another hypothesis must be formulated such as the presence of SMPs being transferred from authorized painted copies of the TS to the Relic when being pressed against each other during the sanctification process.

5. 2. Confirmation of the hypothesis formulated above

Studying more in-depth Ref. [1], we see that something confirms the results reported above. From the spectral analysis reported in Table 1 of Ref. [1], we see that the volume percentage of blood on a single colored fiber is $\geq 90\%$ while that of SMP is $\leq 10\%$. In addition, Figs 1, 2, 4 and 6-SM of the same paper qualitatively confirm at microscopic level the relatively low percentage of SMP thus leading to suppose their small influence in the bloodstain coloration.

Fig. 5 shows a reddish linen fiber taken from STuRP sticky tape 1HB from STERA Inc. through both an optical microscope and an Environmental Scanning Electron Microscope

(ESEM). It confirms the small areal density of the iron SMP. In fact, while Figs. 5 A and B show a wide red area of blood, Fig. 5 C evidences the relatively low area of heavier SMP of iron and mercury evidenced under ESEM.

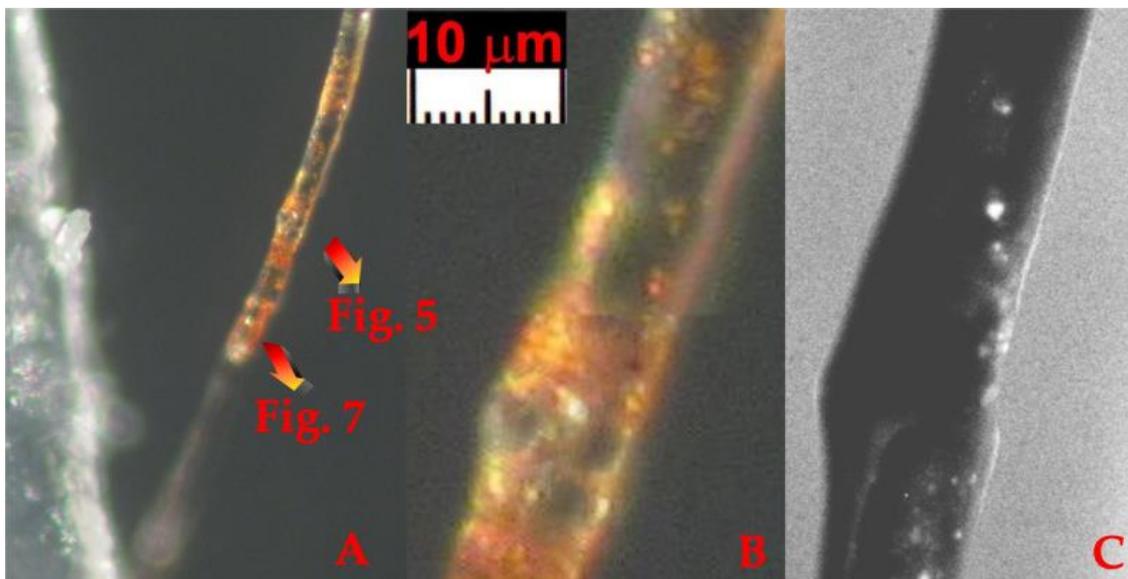


Figure 5. A. Reddish fiber taken from STuRP sticky tape 1HB of STERA Inc. seen in incident light through an optical microscope. B. Detail of photo A in correspondence to the arrow showing the reddish area of blood. C. Same portion of fiber shown in photo B as seen through an ESEM evidencing the smaller areal density of the iron and mercury SMP.



Figure 6. A. The SMP of Fig. 5C colored in red. B and C. Gaussian blur respectively images A and 5B filtered by Gaussian blur in order to simulate the color diffusion along the entire photo. B' and C'. Photos B and C reproduced about 100 times and made smaller to simulate how an observer can perceive a bloodstain on the fabric: while the blood area is visible to the naked eye, the red color of the SMPs almost disappears.

The following experiment has been performed to show what an observer without microscope can perceive when examining a TS bloodstain composed of blood and SMP having the same concentration of red particles as the fiber in Fig. 5. The result of the experiment shown in Fig. 6 demonstrates that the effect of SMPs on the TS are negligible in terms of contributing to the red images that are visible to the naked eye on the TS, such as what is seen in Fig. 5.

Fig. 6A shows the same part of the linen fiber shown in Fig. 5C but brighter with the SMPs colored in red, as they would appear in visible light. Fig. 6B and 6C show the results of filtering by using a Gaussian blur that is respectively applied to Fig. 6A and Fig. 5B in order to simulate the color diffusion along the entire photo. Fig. 6B' and Fig. 6C' are the results of Fig. 6B and 6C reproduced about 100 times and made smaller so as to simulate how an observer can perceive such a bloodstain on the fabric.

When observing the bloodstains on the TS, any contribution of SMPs containing iron or mercury to the redness that is observable with the naked eye is negligible. Instead, the source of the red bloodstains is the porphyrins, which give hemoglobin in blood its characteristic red color.

5. 3. Iron mapping on a TS fiber

An elemental mapping of the lower red portion of the linen fiber shown in Fig. 5A has been performed to demonstrate the distribution of iron and oxygen. Fig. 7 shows the fiber portion of Fig. 5A seen with ESEM and the areas of iron (red) and of oxygen (green). Apart from the background of Figs. 7B and 7D (due to the glass supporting the fiber containing oxygen) the partial absence of correlation between these two elements is evident, for example, by examining the upper red spot of iron, where scarcely a visible green spot of oxygen that corresponds with it can be detected.

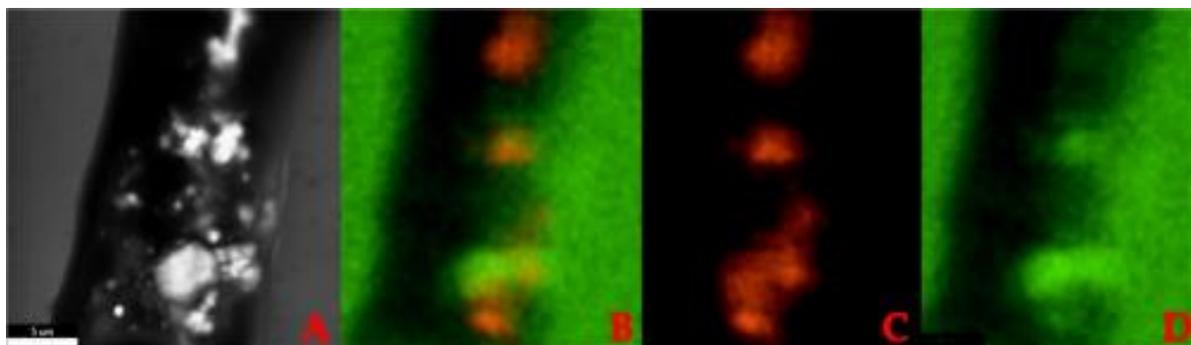


Figure 7. A. The lower portion of fiber taken from STuRP sticky tape 1HB of STERA Inc. is shown in Fig. 6A. B. Iron (red) and oxygen (green) mapping on fiber. C and D. Corresponding single mapping of iron (red) and oxygen (green) respectively.

Instead, the lower green spot of oxygen shown in Fig. 7D appears greater than the corresponding spot of iron of Fig. 7C. These differences can, perhaps, be studied more in detail; however, they seem to demonstrate that on the fiber under analysis there are other kinds of material rich of oxygen, like silicates, which are not generally reddish. Therefore it seems that, in addition to the blood which is obviously red, other materials (that are not only red) also appear on the linen fibers taken from a bloodstained area on the TS.

A mapping of mercury and sulfur has, also, been performed, but only one SMP was found on a portion of the fiber from Fig. 7A. Other SMPs of mercury were detected on other TS fibers, but they were always coupled with sulfur, thereby evidencing that the particles in question are chemically bonded to form mercuric sulfide/cinnabar/vermillion and not native mercury as someone can suppose.

5. 4. Viscoelastic property of TS blood

Generally, we have seen that the percentage of blood in the TS's red stains is far higher than that of red SMPs. A further confirmation of this comes from the observation in Fig. 8A, which shows a bundle of fibers coming from the TS that are trapped in a blood crust.

By applying pressure with a needle on the coverglass holding the sample, the plasticity of the red blood crust is observed as it deforms as a direct result of this application of pressure. Moreover, as that blood crust deforms and adapts to the flat shape of the surface of this glass slide, specular reflection is observed, see Fig. 8B.



Figure 8. Bundle of TS fibers trapped within a blood crust coming from Filter “h” of G. Riggi di Numana taken in 1978. A. Bundle seen in partially reflected and partially transmitted light. B. Bundle seen in the same conditions of A, but under pressure exerted from a needle on the coverglass. The pressure acting on the sample under examination magnifies the red spot in the center of the fiber bundle and, due to the plasticity of the blood, produces a specular reflection of the blood surface.

This obviously happens for material having mechanical characteristics of plasticity such as blood. However, this does not happen for minerals such as iron oxide and cinnabar, which would shatter if subjected to a compression similar to that applied in this test. Therefore, this is another confirmation that the red crusts of the TS are principally of blood. Here we take the opportunity to review a statement made by R. Rogers after he personally analyzed the TS

samples taken during the STuRP's 1978 investigation of it. Rogers stated in (G. Fanti et al., Evidences for Testing Hypotheses ... III, Dallas Int. Conf. on the Shroud of Turin, Texas, September 8-11, 2005) that "*microscopic observation of blood flecks of sample 3EB showed specular reflection: the blood went onto the surface as a liquid.*"

In fact, from the result shown in Fig. 8, the specular reflection observed by R. Rogers from his sample mounted on a microscope glass might not necessarily have been due to the blood having arrived in a liquid state in that area. It might, instead, be due to the plasticity of the blood crust, as is the case of Fig. 8. In fact, as shown above, when a blood crust is observed by an optical microscope, it is generally trapped between a glass and a cover glass; if for some reason this cover glass exerts a pressure on the crust, it deforms plastically showing the specular reflection in question.

5.5 .Why are the bloodstains on the TS still so red?

Dried, old bloodstains are, barring very atypical circumstances, dark brown to blackish in color whereas the bloodstains on the TS have remained curiously reddish in color for many centuries. While the pigment-reinforced hypothesis mentioned in Ref. [1] provided a plausible explanation for the TS's still-red bloodstains (because of surmised, subsequent reinforcement of the blood stains with iron oxide and mercury sulfide pigments) the present paper has shown that the areal density of SMPs is insufficient to explain the reddish color of the TS blood. It is, therefore, excludable as a viable explanation for the redness of the bloodstains.

However, now that this hypothesis has been dismissed the question about the redness of the TS blood is, once again, in search for a satisfactory explanation.

In the past, several other hypotheses have been formulated to explain the still-red bloodstains on the TS. Since the body image and bloodstains on the TS indicate that it was the burial cloth of a victim who suffered both a scourging and crucifixion, P.L. Baima Bollone et al. (Il significato del colore delle macchie di sangue della Sindone ed il problema della bilirubina, Sindon Nuova Serie, No, 15, 2001, pp. 19-29) hypothesized that the continued red color of the bloodstains on the TS were, and are, due to carbon oxide. This carbon oxide would have been produced by the breakdown of erythrocytes (due to the aforementioned torture) which would have bound to hemoglobin, thereby producing carboxyhemoglobin, which would be responsible for the continued reddish color of the bloodstains.

C. Goldoni (The Shroud of Turin and the bilirubin blood stains, Ohio Shroud Conference (2008), www.shroud.com/pdfs/ohiogoldoni.pdf) and A. Di Lascio [27] hypothesized that the continued reddish color of TS bloodstains are caused by a possible high bilirubin content (due to the aforementioned torture) with the additional exposure to that blood to a sufficient dose of UV rays. Although high doses of UV rays might be related to a burst of energy that probably produced the TS body image (J. Jackson, Is the image on the Shroud due to a process heretofore unknown to modern science? 2014: www.shroudofturin.com/Resources/ShroudFallThroughSDTV2.0.pdf), these assumptions do not, however, seem entirely convincing.

Among the various hypotheses that have been formulated to explain the enduring redness of the bloodstains on the TS, the author proposes a new one, along with the following reminder. Evidence should never have its legitimacy lost or diminished, solely, because it is discovered within a theological context. The scientific process, when performed properly, should be neutral. As such, all evidence deserves to be judged on its own merit.

In Italy, on October 31, 2020, a Eucharistic Miracle was claimed to have occurred and in the following way: a Consecrated Host fell to the church floor, was retrieved, and, then, consumed. The area of the church floor where the Host had made contact was, subsequently, cleaned with a linen sheet. A few days later, millimeter-sized blood clots are alleged to have formed on this linen sheet.

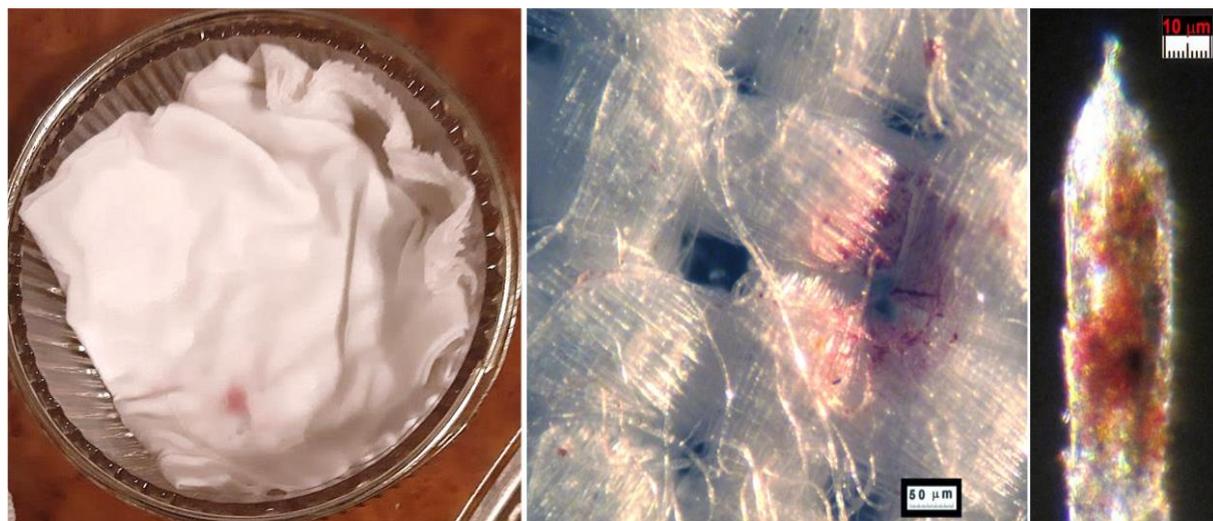


Figure 9. On the left blood on a linen sheet resulting from an alleged Eucharistic Miracle exhibiting its unusual and continued redness after one year; on the center a smaller bloodstain of the same linen sheet tested in Fig. 10. For comparison, on the right is the still red centuries old blood coming from a TS fiber taken from the 3EF sticky tape (STERA Inc.).

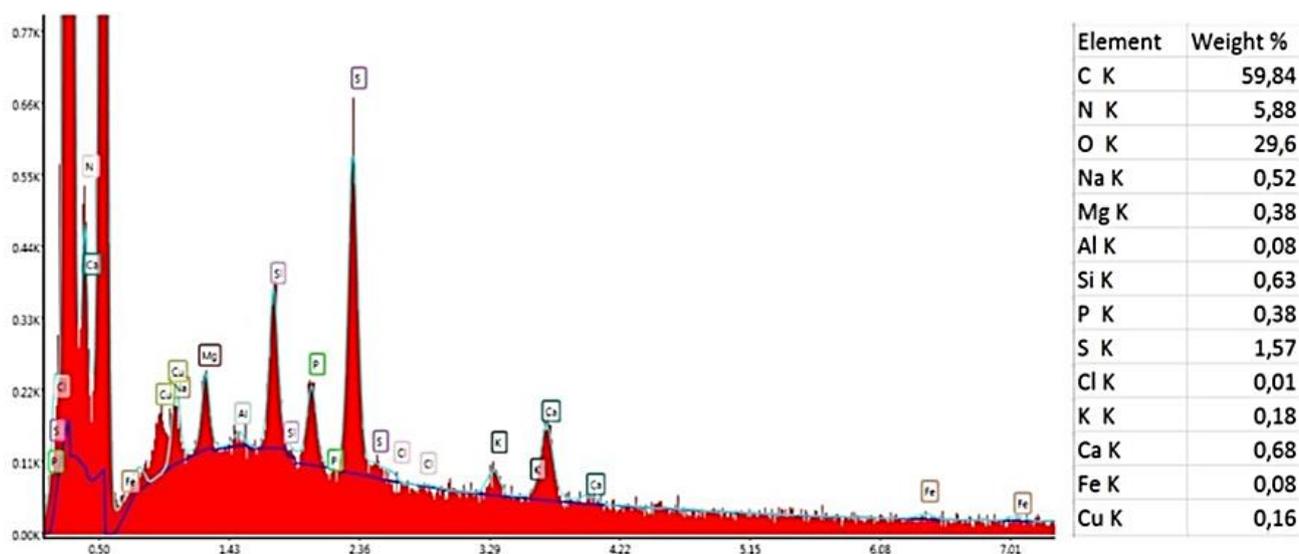


Figure 10. EDX spectrum of blood on a linen sheet resulting from the alleged Eucharistic Miracle in Fig. 9 and the corresponding semi-quantitative elemental analysis of its weight. The presence of aluminum in the spectrum is due to the effect of the stub supporting the sample.

The author was asked to investigate and study the aforementioned blood clots on this linen sheet in February of 2021, which he did. As part of the information gathering process, the author took photographs of these apparent blood clots, see, for example, Fig. 9. It is noteworthy that, even at the time of the writing of this paper in November 2021 (and as this investigation is still ongoing) the color of these clots remains red. For example, Fig. 10 reports one of the tests performed on these blood clots, which shows the EDX (Energy Dispersive X-Ray analysis) spectrum of the red crust under analysis as having congruence with blood.

The author of this paper therefore wonders if the color still red after millennia of the blood of the TS, is perhaps a sign not easy to explain scientifically but that refers to a "still living blood" of the Person who impregnated it on the Relic like that of the supposed Eucharistic Miracle just considered.

6. CONCLUSION

The present work reassesses a previous paper [1] where it was hypothesized that the SMP of iron oxide (hematite or red ochre) and mercuric sulfide (cinnabar or vermilion) found on the TS had been derived from adding pigment carried out in the past centuries to enhance the color of the TS bloodstains.

Verified through X-Ray photographs and through quantitative tests also deriving from analysis of the STuRP results, this work highlights that the amount of SMP found in correspondence with the bloodstains are insufficient to significantly alter the continued reddish color of the TS bloodstains. In other words, SMPs can be reasonably excluded as the source of the red matter that is visible with the naked eye on the TS. As such, the following questions arise which can no longer be accounted for with the hypothesis mentioned in Ref. [1].

First, it is interesting to know what is the origin of the SMPs found in correspondence with the TS's bloodstains. A hypothesis to be confirmed by future studies is based on the fact that the more than 50 painted copies of the Relic made in past centuries may have transferred some pigment when they were pressed to the TS, making them higher order relics.

Second, the question that remains unresolved is that the bloodstains on the TS have retained a reddish color which is in stark contrast to the dark-brown to blackish color that is typical of aged blood. To find a plausible explanation for the continued redness of the TS's bloodstains, in addition to the hypotheses concerning (1) the effect of ultraviolet rays on the high-bilirubin content in the TS's bloodstains (C. Goldoni and P. Di Lascio [27]) and (2) the presence of carboxyhemoglobin in the aforementioned bloodstains (P.L. Baima Bollone), the author considers a new hypothesis. As he is involved in an ongoing investigation on an alleged Eucharistic Miracle concerning a linen cloth with blood on it, he observes that this blood has atypically retained its red color for one year and therefore he supposes there may be a connection between the two blood types, that can be better studied in the future.

The studies involving the TS are in continuous development in search of the Truth that perhaps Science will never be able to completely reach.

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