

Status of Research on the Shroud of Turin

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Abstract

More research has been done on the Shroud of Turin than any other ancient artifact. Many dedicated individuals and groups in many countries are doing this research, yet many controversies remain due to the small size of most samples and lack of access to the Shroud. This paper summarizes five areas related to this research. Regarding philosophy, research on the Shroud should be done by following the evidence where it leads, which is forensic science, while rejecting the requirements of naturalism so that the researcher can have a neutral mindset in the research. There is a continuous history of the Shroud back to about 1356, but there is convincing evidence that it was in Constantinople prior to 1204 AD, with copies of it in art and coins back to the 6th and 7th centuries. There is good evidence that the image was caused by radiation that altered the structure of the organic compounds in the linen fibers, perhaps by means of a static discharge from the fibers. This radiation must have been emitted from within the body to carry the information from the body to the cloth that was required to control the mechanism that discolored the fibers. The best explanation for the carbon dating of the Shroud to 1260 to 1390 AD is that neutrons were included in this radiation. These neutrons formed new C¹⁴ in the fibers which could have shifted the C¹⁴ date forward by up to thousands of years, depending on the location on the Shroud. The most reasonable conclusion is that the Shroud of Turin is the authentic burial cloth of Jesus, and that the image resulted from a unique event involving Jesus' body as it was wrapped within the Shroud.

1. Introduction

A shroud is a large cloth in which a person is buried. Turin is a city in northwestern Italy. Thus, the "Shroud of Turin" refers to a famous burial cloth that has been in Turin, Italy, since 1578. It is about 14.3 feet long and 3.6 feet wide. The astonishing thing about this cloth is that it contains full size front and back images, without pigment, of a naked man who was crucified exactly as the Gospels describe Jesus was crucified. Details of what is on the Shroud are shown in Figure 1. Ancient tradition also claims it is the authentic burial cloth of Jesus. To determine whether this could be true, more research has been done on the Shroud of Turin than on any other ancient artifact. Scientific research on the Shroud started in 1898 when the first photograph of it was taken by Secondo Pia. This research is sometimes called sindonology based on the Greek word (sindon) used for the linen cloth in Mt. 27:59, Mark 15:46, and Luke 23:53. This research has many difficulties which result in many controversies because: 1) there is very limited access to the Shroud, 2) the size of samples is often extremely small, 3) there is often difficulty in proving that a particular sample came from the Shroud, and 4) the confusion caused by many possible sources of contamination. Another significant problem is that current research on the Shroud occurs at the intersection of philosophy, historical and scientific evidence, and religion. Erroneous assumptions in any of these areas can have a negative impact on Shroud research. These areas are discussed below.

2. Current Research on the Shroud

Research is currently being done by dedicated individuals and groups in several countries, particularly in Italy by researchers such as Giulio Fanti (Ref. 1), Emanuela Marinelli (Ref. 2), and Paolo Di Lazzaro (Ref. 3). In the United States, physicist Dr. John Jackson (Ref. 4) led the Shroud of Turin Research Project (STURP) in 1978 and currently leads a research group at The Turin Shroud Center of Colorado (www.shroudof-turin.com) located in Colorado Springs. Photographs taken by Vernon Miller, the main scientific photographer at the STURP investigation, are at <https://www.shroudphotos.com/>. Attorney Mark Antonacci in St. Louis has written two books on the Shroud (Ref. 5 and 6) and founded the Test the Shroud Foundation (www.testtheshroud.org) to promote further testing of the cloth. The author (www.shroudresearch.net) leads a Shroud research team in Richland, WA, in association with the Test the Shroud Foundation. Research on the Shroud is published in peer-reviewed journals, on the internet, at conferences, and in books. Though most books on this topic are in other languages, many good books have also been written in English (Ref. 5 to 12). Russ Breault (www.shroudcouter.com) has been lecturing on the Shroud for 25 years. Barrie Schwartz, located just west of Colorado Springs, founded and manages the largest website dedicated to the Shroud (www.shroud.com) where several hundred scientific papers are available. This website also lists papers presented at Shroud conferences. The author organized the previous international conference held July 19 to 22, 2017, in Pasco, WA. Papers presented at this conference are available at <http://www.shroudresearch.net/conference-2017.html>. The next conference (<http://custance.wpengine.com/conference/science-theology-and-the-turin-shroud/>) is scheduled for August 14 to 17, 2019, in Ancaster, Canada, southwest of Toronto.

3. Philosophy of Shroud Research

The methodology that should be used in scientific research on the Shroud is an important philosophical question. Many argue that naturalism must be assumed. In practice, what this means is that the only explanations allowed are those consistent with our current understanding of the laws of physics and science. I will use this definition in the following considerations. There are significant problems with such an assumption of naturalism in Shroud research.

- New phenomena and laws are the very essence of the historical development of science. The greatest leaps forward in our understanding of reality are always outside or beyond our then current understanding of science. Science should always be open to new discoveries, new laws, or modification of existing laws, as new variables and phenomena are discovered and considered. In the past, naturalism has not been used to object to or prohibit the consideration of new phenomena and new laws. For these same reasons, naturalism should not be used to restrict research on the Shroud of Turin.
- Science can be defined as the pursuit of the truth by careful observation of repeated experiments varying all known variables that affect the results. When possible, the results are expressed in mathematical equations so that a hypothesis can be developed to explain the phenomena. This is done so predictions can be made which are testable, so that the hypothesis is falsifiable. It should be noticed that naturalism is not mentioned in this definition of science, so naturalism is not a requirement of science.
- The scientific method as defined above, is not able to prove that at our current understanding of how physical reality operates is so complete and precise that it will never need changing.

- Naturalism does not result from science. Naturalism is the result of the philosophy of scientism (Ref. 13). Scientism is often confused with science, especially by scientists.
- Repeated experiments have never been done in which a human body produced an image of itself on fabric. This is because there is no known mechanism for a human body to encode an image of itself on fabric. Yet based on the evidence, the Shroud shows an image of the body that was wrapped within the cloth. Thus, there is currently no known way that it could have happened, yet it has happened. This implies that we ought to be open to the possibility that the cause may be outside or beyond our current understanding of the laws of science.
- Scientific research on the Shroud since 1898, when Secondo Pia took the first photograph of it, has usually assumed naturalism. But this research has not led to solutions to the mysteries of the Shroud. Thus, to find a solution to the mysteries of the Shroud, we ought to be open to thinking “outside the box” created by the restrictions of naturalism.
- The philosophy of naturalism assumes our science is so precise and complete that all phenomena must be consistent with it. For hundreds of years, experiments in classical physics attempted to account for all variables in our four-dimensional view of physical reality consisting of three dimensions in space and one dimension in time. But string theorists now believe that to explain experiments in modern physics, reality must consist of from 10 to 26 dimensions depending on the specific string theory, with our four dimensions being only a small subset of the total. If this is true, it means that events in our four dimensions could be affected by variables in the larger dimensionality, so the variables in our four dimensions are not all the variables. Thus, especially in the case of research on the Shroud, we are not justified to assume that all explanations must be consistent with our current understanding of the laws of science, i.e. naturalism.
- In rejecting the necessity of assuming naturalism, we are not then confined to thinking in terms of miracles, the supernatural, or Jesus’ resurrection. Rather, we only need to recognize that something may have occurred that was outside or beyond our current understanding of the laws of science. In this way, the researcher can maintain a proper scientific methodology and approach the investigation with a neutral mindset that the Shroud may or may not be Jesus’ burial cloth and the image may or may not have been caused by a unique event that is outside or beyond our current understanding of the laws of physics and science.

Some have also argued that true science cannot be done on any unique non-repeatable event because science involves repeated experiments. It is then argued that scientific research is not possible on the Shroud because we cannot perform repeated experiments in which a dead body creates an image of itself on linen. But this argument fails to recognize the difference between experimental science and forensic science. There are many areas in which science can be done on the results of a unique non-repeatable event. For example, when a murder is committed, it is a unique non-repeatable event, yet science can still be done on the results of the event. To help determine who committed the murder, forensic specialists can take finger prints, perform tests on the body to determine the time of death, consider blood splatter and bullet trajectories, analyze pollen and fiber samples, etc. The essence of forensic science in this example is following the evidence where it leads apart from presuppositions as to who might have committed the murder. This is how scientific research ought to be done on the Shroud – by following the evidence where it leads without presuppositions. The researcher should be very careful to approach the research with a neutral mindset, i.e. that the Shroud may or may not be Jesus’ burial cloth, that the image may or may not have been produced by the body, and that the image may or may not have been produced by phenomena outside or beyond our current understanding of science. This requires that

naturalism not be assumed in the research. Thus, the researcher should not be goal oriented but should follow the evidence where it leads.

4. History of the Shroud of Turin

According to research on documents, traditions, coins, artistic works, pollen, and DNA the following is the most likely history for Jesus' burial cloth (Ref. 4, 10, and 14). Jesus' linen burial shroud was found by Peter and John in the tomb after Jesus' crucifixion in Jerusalem (John 20:3-9). Because it was one of the few things left behind by Jesus and because it had Jesus' blood on it, it is very unlikely to have been ignored, reused, burnt or thrown out. Due to its importance, it probably would have been protected from moisture, insects, and intentional destruction. Under these conditions, the linen shroud would only decay by oxidation and dehydration which are very slow processes, so it could easily survive for thousands of years. There are many examples of linen lasting much longer than 2000 years.

Galatians 3:1 (~ 47 to 56 AD) indicates the believers in Galatia were shown something that "clearly" or "publicly portrayed" "Jesus Christ ... as crucified" (NIV & NASB). The Greek word translated "portrayed" in this verse, "proographa", is one of the sources of our English word "graphic" and can be translated as "signboard" (NLT) or "placard" (Wuest). Based on the meaning of this Greek word and the context in the sentence, this could have been a physical object containing an image which communicated that Jesus had been crucified. They had seen it with their "very eyes" (NIV). A very reasonable explanation is that they saw Jesus' burial shroud containing his blood and possibly his image.

Many of the early believers, when they fled Jerusalem to avoid persecution, went to Antioch (Acts 11:19) so it became the center for Christian outreach (Acts 11:26, 13:1). A tradition preserved in the writings of Athanasius (298–373 A.D.) indicates that prior to the destruction of Jerusalem in 70 AD, Christian relics, including the icon of our Lord, were brought from Jerusalem through Pella to Syria, perhaps Antioch. Ancient texts and an inscription indicate Jesus' shroud may have been involved in the conversion of King Abgar the Great of Edessa in Mesopotamia probably in the second century.

The image that is now on the Shroud of Turin was frequently copied in Byzantine art. The earliest surviving example is the Christ Pantocrator painting from St. Catherine's Monastery at Sinai, which probably dates to about 550 AD. The Shroud was most likely brought to Constantinople, the capital of the Byzantine Empire, in 574 as the Image of God Incarnate. An alternate theory is that it was brought to Constantinople in 944 as the Mandylion or Image of Edessa. Its presence in Constantinople long before the C¹⁴ date of 1260 to 1390 is confirmed by Byzantine coins starting in 692, the Hungarian Pray Manuscript (1192-1195), and the report (1203-1204) of French crusader Robert de Clari that Jesus' burial cloth was exhibited weekly at the Church of St. Mary in the Blachernae district of Constantinople. It may have been sold by Byzantine emperor Baldwin II to his cousin, King Louis IX of France, between 1237 and 1261. Others believe it may have been stolen from Constantinople in the sack of the city in 1204. In about 1355 it was exhibited in Lirey, France, as the true burial cloth of Jesus by the French knight Geoffrey de Charny, the grandson of Jean de Joinville, a principle adviser to King Louis IX. In 1453, it was sold by Geoffrey de Charny's granddaughter to Louis, the Duke of Savoy. It was then gradually transported across France till it came into Turin, Italy, in 1578. This historical evidence, when combined with the results of the scientific investigation of the Shroud, is sufficient to convince most

researchers that the Shroud of Turin is very likely the authentic burial cloth of Jesus. No other alternative satisfies all the historical and scientific evidence.

5. Image Formation on the Shroud of Turin

How were the front and back images of a crucified man formed on the Shroud? The main objective of the Shroud of Turin Research Project (STURP) was to study this question. In 1978, they sent about 26 researchers from the US to Turin, Italy, to perform hands-on non-destructive testing of the Shroud for five days, 24 hours a day. Their experiments determined that the image contains no pigment, no carrier, no brush strokes, no clumping of anything between the fibers or threads, no capillarity (soaking up of a liquid), no cracking of the image along the fold lines, and no stiffening of the cloth. Many or all these would be present if the image were due to paint, dye, or stain, yet none of them are present. Their experiments also proved the image is not due to a liquid, a scorch, a photographic process, or any other process that they could conceive of (Ref. 4, 5, and 9).

Subsequent analysis by STURP proved the straw-yellow discoloration that forms the image is only on the top one or two fiber layers in a thread, whereas a thread contains about 100 to 200 fibers. The discoloration on a fiber is about 0.2 microns (millionths of a meter) thick around the outer circumference of the approximately 20-micron diameter of a fiber. The discoloration is caused by a rearrangement of the electron bonds of the carbon atoms that were already in the cellulose molecules in the flax fibers in the linen threads, so that the discoloration does not result from new atoms added to the cloth! The discoloration results from single electron bonds, that bond the carbon atoms to the surrounding atoms, being changed to double electron bonds. This change from single to double electron bonds of the carbon atoms took place in a pattern to create the front and back images of the crucified man on the Shroud! Thus, the discoloration is due to energy added to the cloth but without substance, i.e. atoms, being added to the cloth. The energy was evidently added to the cloth in one or more very short powerful bursts of radiation so that the electron bonding could be altered before the energy penetrated beyond the top one or two layers of fibers in a thread.

Based on these unique characteristics, most researchers conclude that the image on the cloth could not have been made by an artist or forger in any previous era. The only other option is that the Shroud wrapped a real body of a man who died by crucifixion, and that this body in some unknown way created the image. Details of the image formation mechanism are not fully understood, but some things were required to form the image. The mechanism that discolored the fibers required energy to drive it and information to control it. Energy was necessary to change the single electron bonds of the carbon atoms into double electron bonds. Information was necessary to control which fibers were discolored, and the length of that discoloration, so that the pattern of that discoloration could form the image of a crucified man. The required information is that which defines the appearance of a crucified man. This information could only have come from the body that was wrapped in the Shroud (Ref. 15). Of the six processes that can transfer information from one location to another (radiation such as light, waves in a medium such as sound waves, a flow of particles in physical connections such as wires, direct contact, diffusion of molecules, and pulses in a gravitational or electrostatic field) only radiation could have transferred the focused information from the body to the cloth (Ref. 16). This focused information is required to form the good-resolution images on the Shroud. We can see the image because this information has been encoded into the pattern of discolored fibers that make the image. Experiments

have shown that ultraviolet light (Ref. 3), infrared light (Ref. 17), and protons (Ref. 18) can discolor linen fibers.

If we follow the evidence where it leads, without assuming we are limited to our current understanding of the laws of physics, we conclude that the image was formed by radiation damage to the molecules in the linen. This radiation, by its intensity and direction, carried the information from the body to the cloth which was necessary to form the image. Thus, this radiation came from the body, but was probably not emitted from the surface of the body. More likely, it was emitted from within the body as it was wrapped within the Shroud, since bones (teeth, bones in the hands, etc.) can be seen in the image, like an X-ray. The radiation had to carry the information related to the presence of these bones from the body to the cloth and deposit it there. The presence of the front and back images without side images is most easily explained by the radiation, when it was emitted in the body, being vertically collimated both up and down (Ref. 19).

6. Carbon Dating of the Shroud of Turin

Results of the Shroud of Turin Research Project (STURP) in 1978 supported the authenticity of the Shroud, but this was brought into question by carbon dating. In 1988, samples were cut from the corner of the cloth and sent for C^{14} dating at three laboratories in Tucson, Zurich, and Oxford. The average date from the three laboratories (Ref. 20, Damon) was 1260 ± 31 AD, which produced a range of 1260 to 1390 AD when corrected for the variable amount of C^{14} in the atmosphere. Subsequent statistical analysis (Ref. 22) of the data published in Damon, et al (Ref. 20) found strong evidence the variation in the laboratory's measurements was not only due to random effects but very probably also due to something that could have altered the measured dates from the first century to the Middle Ages. In statistical analysis terminology, this "something" is called a systematic bias. Since this bias was not recognized or corrected for, the conclusion in Damon that the Shroud dates to 1260 to 1390 AD should be rejected. The evidence (Ref. 21 and 22) can be summarized as follows:

- Due to its unique characteristics, the image could not have been made between 1260 and 1390 AD because the technology did not exist. The technology to form this image still does not exist.
- 13 other date indicators are consistent with a first century date for the Shroud and inconsistent with the C^{14} date of 1260 to 1390 AD. This includes the Hungarian Pray Manuscript, the image of the face on paintings as early as about 550 AD and on coins as early as 675 AD, use of what is evidently a first-century stitch on the Shroud, measurements of reflectance and tensile strength of the linen, the dimensions of the Shroud (8 by 2 Assyrian cubits), etc.
- Dates from the three laboratories don't agree with each other. The average dates from the laboratories in Tucson (1303.5 ± 17.2) and Oxford (1200.8 ± 30.7) are statistically different (difference = 102.7 ± 35.2) from each other at the $102.7 / 35.2 = 2.9$ sigma level, which is above the normal 2.0 sigma acceptance level.
- Plotting the average values from the three laboratories indicates there is a gradient or slope to the C^{14} date of about 36 years per cm of distance from the bottom of the Shroud. This indicates that something altered the C^{14} date measurements as a function of (depending on) the original location of the sample. Nuclear analysis computer calculations (Ref. 23) indicate this slope in the C^{14} date of 36 years per cm could be due to the distribution of neutrons in the tomb if they were emitted from within the body.

- When a Chi-squared statistical analysis is performed on all the measurements and uncertainties, the C^{14} date measurements have only a 1.4% probability of being consistent with the uncertainties. This indicates about a 98% probability that something altered the measurements. This something, or bias, changed the measurements by about 36 years per cm as stated above.
- The date of 1260 to 1390 AD (Damon, et al) for the Shroud was based on ignoring half the data, i.e. all measurement uncertainties. It is not legitimate to simply ignore all the measurement uncertainties: 1) they were obtained using the same equipment and procedures as the measurements, 2) they were reasonably consistent for all laboratories, and 3) they were reasonably consistent with the uncertainties for the three standards that were run at the same time as the Shroud samples.

What altered the measured dates? Evidence indicates the image was formed by a burst of radiation emitted from within the body (Ref. 16). Atoms that make up the body are composed of protons, neutrons, and electrons. If neutrons were included in this burst of radiation (Ref. 23), a small fraction of them would have been absorbed in the trace amount of N^{14} in the threads to create new C^{14} in the Shroud by the $N^{14} + \text{neutron} \rightarrow C^{14} + \text{proton}$ reaction. To shift the C^{14} date for the samples from about 30-33 AD (the death of Jesus) to 1260 AD requires only a 16% increase in the C^{14} content at the sample location. If only one neutron were emitted from the body for every ten billion that were in the body, this would have been enough to increase the C^{14} content by the required 16% at the sample location.

Other than an assumption of naturalism and the carbon dating problem, the two main objections to the authenticity of the Shroud are the d'Archis memorandum and Walter McCrone's painting hypothesis. These objections are discussed in Section 6 of "Evaluation of 'A BPA Approach to the Shroud of Turin'" (Ref. 24).

7. Is it the Image of Jesus?

Experiments conducted by the Shroud of Turin Research Project (STURP) in 1978 indicate the characteristics of the image are so unique it could not have been made by an artist or a forger. The only other option is the image was made in some way by the body wrapped within the Shroud. But who's image is it? Could it be the image of Jesus? In a court of law, there are two general ways to determine the identity of a person – by eye-witness testimony based on how the person looks, and by circumstantial or physical evidence such as identification cards, DNA, fingerprints, shoe prints, pollen, fibers, etc. Consider application of these identification methods to the image on the Shroud.

When you look at the cloth (Figure 1), you see good-resolution front and back images of a crucified man: a severe flogging, a nail wound in the only wrist that is visible, blood running down the arms with the angles of blood flow consistent with crucifixion, and nail wounds in the feet. Additional aspects relate to how Jesus was specifically crucified: a cap of thorns that was beat into his scalp, a puncture wound in the side with a hole the size of a Roman thrusting spear, post-mortem (after death) blood running down from the side wound, and legs not broken. The image also indicates he was dead: the curvature of the feet due to rigor mortis, and blood from the side wound separated into its components, referred to as "blood and water" (John 19:34). Closer examination indicates swollen cheeks from a beating to the head, damaged nose from this beating or a fall, abrasions on both shoulders from carrying a rough heavy object, a section of his beard missing, and no body-decay products present, all consistent

with the image being Jesus. Microscopic examination is also consistent with the image being Jesus: dirt was found in abrasions on the tip of his nose and on one knee consistent with a fall, there was pollen from Jerusalem on the Shroud and pollen around his head from a plant with long thorns, and there were small chips of limestone near the feet containing impurities that match limestone in Jerusalem. Chemical analysis indicates that what appears to be blood is real human blood and that it contains bilirubin, made by the liver in processing damaged red blood cells resulting from the severe flogging. The face on the Shroud also agrees with our concept of how Jesus looked. This is because our concept is based on the earliest paintings of Jesus (~ 550 AD) which were evidently based on the Shroud. All evidence is consistent with the image being Jesus.

No human body, alive or dead, has ever produced an image of itself on fabric. The only exception is the Shroud with its image of a crucified man. The two criteria to identity of this man are:

- Based on the nature of the blood on the Shroud (pristine appearance, intact edges, clear blood serum around the dried blood), the blood must have come from a real human body that was wrapped within the Shroud. Based on the image on the Shroud, the body wrapped within the Shroud was the dead body of a man that had been crucified.
- Based on the STURP analysis, the image on the Shroud is not due to paint, dye, stain, liquid, scorch, or a photographic process. Evidence (Ref. 16) indicates the image is due to radiation damage to the linen caused by a burst of radiation emitted from within the body that was wrapped within the cloth. We have no other example of this happening. It was evidently a unique event.

Thus, the question is, what man who died by crucifixion could have gone through a unique event in which his dead body emitted such a powerful burst of radiation that it encoded an image of itself onto the linen cloth in which it was wrapped? If one looks through all mankind's historical records, only Jesus and his reported disappearance from within his burial shroud satisfy these two criteria. Thus, the most reasonable conclusion is that the image on the Shroud of Turin is Jesus. Using this conclusion, a holistic explanation for the mysteries of the Shroud can be developed (Ref. 25).

Biography

Robert A. Rucker earned an MS degree in nuclear engineering from the University of Michigan and worked in the nuclear industry for 38 years primarily in nuclear reactor design, nuclear criticality safety, and statistical analysis for quality control of nuclear material inventories. He holds Professional Engineering (PE) certificates in nuclear engineering and in mechanical engineering. He organized the International Conference on the Shroud of Turin (ICST-2017) held July 19-22, 2017, in Pasco, Washington. His papers can be downloaded from the research page of his website at <http://www.shroudresearch.net/research.html>. Send comments, questions, or corrections to robertarucker@yahoo.com.

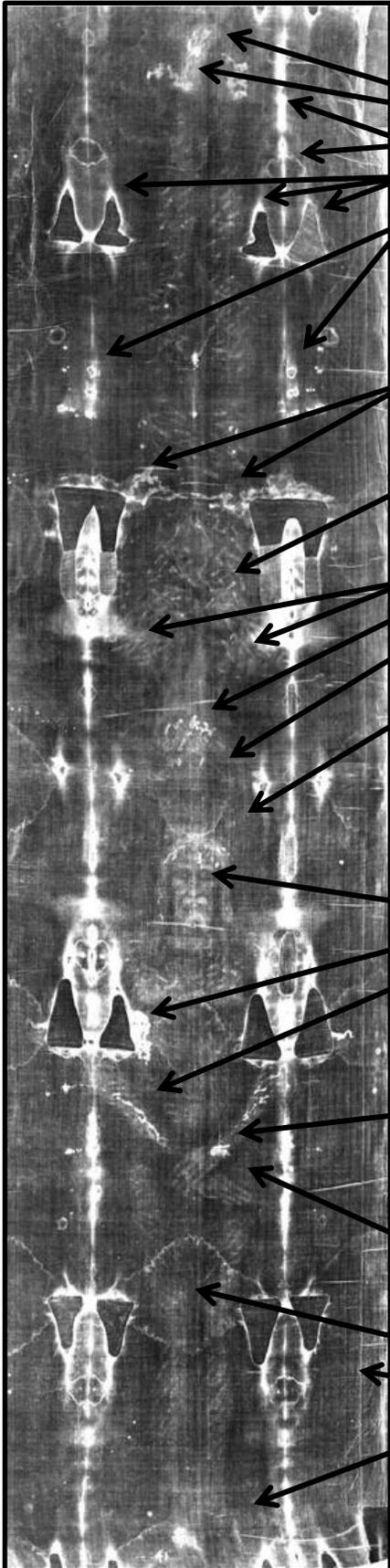


Figure 1. Front and Back Images on the Shroud of Turin

1. Rigor mortis in the feet. This indicates the victim was dead.
2. Two nails through one foot, one of them through both feet.
3. Fire in 1532 resulted in scorch marks and water stains.
4. Areas badly damaged in the fire were patched in 1534.
5. The Hungarian Pray manuscript (1192-1195) has a painting of a famous burial cloth that had long been in Constantinople. It shows the same L-shaped burn holes that are on the Shroud, so the Shroud must have existed significantly (more than 2 sigma) before the C¹⁴ date of 1260 to 1390 AD. Thus, this C¹⁴ date must be flawed.
6. The Shroud appears to show a flow of blood and clear blood serum from a wound in the side. Blood serum is mostly composed of water. Compare this with “blood and water” in John 19:34.
7. The Shroud shows 100 to 120 scourge marks from Roman flagrum. Resulting blood marks show blood serum rings (visible only under UV) around the blood particles. Compare with Mk. 15:15.
8. Abrasions on both shoulders from carrying a rough heavy object.
9. Puncture wounds from sharp objects pierced his scalp.
10. Pollen on the Shroud unique to the area around Jerusalem. Pollen from a plant with long thorns found around his head.
11. The images are negative images and contain 3D information that indicates the distance of the cloth from the body. Only the top 1 or 2 layers of fibers in a thread are discolored. The discolored fibers in the image result from the carbon atoms that were already in the cellulose molecules in the flax fibers being changed from single to double electron bonds, yet this produced the image of a naked crucified man.
12. Swollen cheeks and damaged nose from a beating or a fall.
13. Side wound shows a hole the size of a Roman thrusting spear.
14. Blood running down arms at the correct angles for crucifixion. Blood is real human blood, male, type AB. The blood with high bilirubin content and nanoparticles of creatinine bound to ferritin indicate he was severely tortured. Blood from the side wound is post-mortem.
15. Paintings from the Middle Ages show nails through the palms, but this will not support enough weight since there is no bone structure above this location. The Shroud shows the correct nail locations - through the wrist instead of the palm.
16. Shroud correctly shows thumbs folded under due to contact of the nail with the main nerve that goes through the wrist. This is also contrary to paintings from the Middle Ages.
17. Abrasions on one knee show a microscopic amount of dirt.
18. Three-inch wide side strip sown on with a unique stitch very similar to that found at Masada, which was destroyed in 73-74 AD.
19. Microscopic chips near the feet of travertine aragonite limestone containing impurities that closely match limestone in Jerusalem.

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