Holistic Solution to the Mysteries of the Shroud of Turin

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Abstract

To solve the mysteries of the Shroud of Turin, the Shroud has been researched more than on any other ancient artifact. These mysteries include the image, date, and blood. It would be very attractive if, by following the evidence where it leads, a single concept, referred to in the title as a "holistic solution", could be developed that could explain these mysteries. This paper presents such an explanation. Based on the scientific evidence, it is hypothesized that an extremely rapid intense burst of radiation was emitted from within the body that was wrapped in the Shroud. This hypothesis can explain why we can see the image, how the image was formed, why carbon dating produced a date of 1260-1390 AD for a cloth that is from the time of Jesus (about 30 to 33 AD), how the blood was thrust off the body onto the cloth, why there is no image under the blood, and why the blood has a reddish color. Methods to test this hypothesis are suggested, including measurement of the distribution of carbon dates across the Shroud and detection of long half-life isotopes on the threads and blood on the Shroud and in the proposed limestone tombs.

1. Introduction

This paper documents the presentation with the above title that was made at the 2019 International Conference on the Shroud of Turin, August 14 to 17, 2019 at the Redeemer University College in Ancaster, Canada. Background for the information discussed here is available in the papers "Summary of Scientific Research on the Shroud of Turin", "Explaining the Mysteries of the Shroud of Turin", and "Status of Research on the Shroud of Turin" (Ref. 1, 2, and 3). These papers are available on the research page of the website www.shroudresearch.net.

It is essential to use the proper methodology in researching the Shroud. To the extent possible, the researcher should recognize his own biases and presuppositions, both religious and naturalistic, so that these will not affect his judgment so that objectivity can be maintained. In other words, research should be performed with a neutral mindset, i.e., it should be assumed that the Shroud of Turin may or may not be Jesus' burial cloth, God may or may not exist, Jesus' resurrection may or may not be a real historical event, and there may or may not have been a unique event that is outside or beyond our current understanding of the laws of physics. This last point is the issue of naturalism. As used here, naturalism is defined as the assumption that the only explanations allowed are those that are consistent with the known laws of science, so that nothing can happen that is beyond what we currently know. Naturalism is discussed further in section 3 of Ref. 3. The methodology for researching the Shroud that is advocated here could be called forensic science or reverse engineering. In simple terms, it is following the evidence where it leads, without the restrictions of presuppositions.

In following the evidence where it leads, we are led to the hypothesis that there was an extremely rapid intense burst of radiation from the body that caused the image. Neutrons that were included in this burst of radiation shifted the carbon date in the forward direction consistent with the 1988 carbon dating of the Shroud. Radiation in this burst could have also thrust the dried blood off the body onto the cloth, caused the blood to retain a reddish color without discoloring fibers below the blood, and might have even elevated the upper cloth above the body, as will be discussed below. Thus, the hypothesis of an extremely rapid intense burst of radiation from the body is proposed to explain the mysteries of the Shroud related to the image, the carbon dating, and the blood on the cloth. It is the only single hypothesis that has been proposed to explain these mysteries.

2. Why can we see the Image?

Regarding the mystery of the image on the Shroud (Figure 1), it is important to break this into two sub-issues. Why we can see the image should be distinguished from how the image was formed because in answering the first question (Why can we see the image?), it will help us to answer the second question (How was the image formed?).

We approach the issue by briefly reviewing the history of research on the Shroud. Research started in 1898 when Secondo Pia took the first photograph of the Shroud. To his shock, when he developed the glass plate from his camera, what he expected to be a low-resolution negative image turned out to be a high-resolution positive image. This proved that the image on the Shroud was essentially a negative image, with the dark and light areas reversed. This proved that the image could not be a painting, as most people thought. This is because an artist could not have painted a negative image hundreds of years ago because he never would have seen a negative image, or even been familiar with the concept. If the image was not produced by an artist, and there appeared to be no other realistic option to make the image, then the image was apparently produced by the body that was wrapped in the Shroud. The presence of a crucified body wrapped in the Shroud was confirmed over the next seven decades as researchers primarily studied the nature of the blood on the cloth. The main researchers in this seven-decade period were:

- Dr. Yves Delage, Prof. of Comparative Anatomy, Paris 1900-1902
- Dr. Paul Vignon, Professor of Biology, Paris 1900-1943
- Dr. Pierre Barbet, Prof. of Anatomy, Paris 1932-1961
- Dr. Robert Bucklin, M.D, Forensic Examiner, LA 1941-1993
- Dr. Frederick Zugibe, Chief Medical Examiner, NY 1953-2002
- Dr. Alan D. Adler, Prof. of Chemistry, Conn. State U. 1978-2000
- Dr. John Heller, Prof. of Medical Physics, Yale 1978-1995
- Dr. John Jackson, Prof. of Physics, Air Force Aca. 1978-
- Dr. Baima-Bollone, Chief of Forensic Medicine, Turin 1978-

These researchers had doctorate degrees, many with specialties in anatomy, wounds, and blood, and many researched it for multiple decades. Based on the pristine nature of the blood, the shape

of solidified blood components, and the presence of halo rings around these components that are only visible under ultraviolet light, they concluded that the blood came from a real crucified body that was wrapped in the Shroud.

Dr. John Jackson was a professor of physics at the Air Force Academy in Colorado Springs, Colorado. In the early 1970s, when he placed a photograph of the face on the Shroud under an electronic device called a VP8 Image Analyzer, it was discovered that the image on the Shroud contains 3D information. This 3D information that is recorded on the Shroud represents the vertical distance from the body to the cloth in the wrapped configuration. No other painting or photograph contains 3D information. This amazing discovery led to the establishment of the Shroud of Turin Research Project (STURP). In 1978, the Vatican invited STURP to come to Turin, Italy, to perform experiments on the Shroud of Turin in the Cathedral of St. John the Baptist in Turin, Italy, for five days, 24 hours a day. The only restriction was that the Shroud should not be damaged in the process.

STURP's main goal was to determine the cause of the image. STURP concluded that they found no evidence of pigment causing the image. They also found no carrier, no brush strokes, nothing clumping fibers or threads together, no capillarity (soaking up of a liquid), no stiffening of the cloth, and no cracking of the image along fold lines. This indicates that the image is not due to paint, dye, or stain. Because there is no indication of capillarity, the image could not be due to an acid or any organic or inorganic chemical in liquid form. Under UV light, the scorches on the Shroud from the fire in 1532 fluoresced, but the body image did not. This proved that the image is not a scorch from a hot object. The evidence also argues against the possibility that the image is a photograph:

- There are full-size good resolution front and back images of a crucified man on the Shroud.
- There is 3D information in these images related to the vertical distance between the body and the cloth, yet 3D information is not present in any other photograph.
- There is extreme superficiality of the discoloration in the fibers. Only the top one or two fiber layers in a thread are discolored, and the discoloration in a fiber is less than 0.4 microns thick around the circumference of the fiber, which has a diameter of about 15 microns. The inside of the fiber is not discolored.
- The discoloration in this 0.4-micron layer is caused by a change from single electron bonds to double electron bonds in the carbon atoms in the cellulose. A change from single to double electron bonds can result from the process of oxidation and dehydration associated with aging of linen. But in aging of linen, the image of a crucified man is not formed.
- There is no evidence of capillarity (soaking up of a liquid) in the fibers or threads, so no liquids were used in the process of forming the discoloration in the fibers.
- The discoloration of the fibers is mottled.
- Fibers under the blood are not discolored.
- No residual material was found on the Shroud from a photographic process.
- No hypothesis has been suggested that is consistent with both the macroscopic evidence (how the image looks) and all the above microscopic evidence (the very small-scale characteristics) of the image. If a hypothesis is not consistent with all the above evidence, it cannot be correct.

- For such a hypothetical photographic process to be correct, it had to have formed the image prior to about 1355, which is the date for the Shroud being displayed in Lirey, France. Evidence on the Hungarian Pray Manuscript indicates this date should be pushed back to at least 1192-1195. Evidence on coins and paintings indicates this date should be pushed back to about 550 AD. It was not until 1826 that the first photograph was produced.
- If a photographic process was used to produce the image on the Shroud prior to these dates, it is strange that it was not used to produce any other image in the many years since.

The absence of body decay products on the cloth indicates that the image was not caused by body decay products interacting with ointments placed onto the body. The bottom line is that after five days, 24 hours a day of experiments, they could not explain how the image was formed. STURP's conclusion in 1981 was, "We can conclude for now that the Shroud image is that of a real human form of a scourged, crucified man. It is not the product of an artist." The most reasonable conclusion is that the image was formed by the body of the scourged crucified man as it was wrapped in the Shroud. This agrees with the conclusion of the first eight decades of research on the blood that concluded that the blood that is now on the cloth came from a dead human body as it was wrapped in the cloth. And it is consistent with there being no realistic alternative for a forger to create the image. Thus, both the blood and STURP's experiments indicate that the image and the blood that are now on the cloth are very likely the results of the body of a real crucified man that was wrapped in the Shroud.

The key to understanding why we can see the image on the Shroud is information, both how information is stored and how it is transported from one location to another (Ref. 4). As an example, how is it that one person can see another person? A simplistic answer might be that when you open your eyes and if there is enough light, then you can see the other person, but a more detailed explanation is helpful to understand why we can see the image on the Shroud. The smallest packet of energy that makes up light is called a photon. Photons can carry, transfer, or communicate information in three ways. A photon's energy can communicate color, its intensity (number of photons) can communicate shade (light vs. dark), and the position and angle that it enters the lens of a person's eye can communicate the position of the color and shade of the point being seen. Thus, person A can see person B because the color, shade, and position of every point on person B is communicated to the eyes of person A by photons that reflect off person B, some of which enter the eyes of person A. In fact, every image that a person sees whether in a photograph, magazine, newspaper, television, computer monitor, or in the scene in front of his eyes is based on information. For example, the person in a photograph can be recognized because the information that defines the person's appearance has been encoded into the location of the pixels/dots on the photograph. This information is communicated to the person looking at the photograph by reflected photons.

This principle can be applied to the image on the Shroud. The pixels that make the image consist of the top fibers in certain linen threads that have been discolored into a straw-yellow or sepia color. We recognize the image as a crucified man because the information that defines the appearance of a crucified man has been encoded into the pattern of the discolored fibers in the image. This information had to be deposited on the Shroud to be encoded into the image. And it had to be transported or communicated to the cloth from somewhere else. Since the content of this information is that which defines the appearance of a naked crucified man, it could only

come from one place. It could not have come from the air or limestone in the tomb since this information was not inherent to those locations. It could only have come from the body, because this information (that which defines the appearance of a crucified man) was only inherent to the body. Thus, this information had to be transported from the body to the cloth and deposited there. Photons of infrared, visible, and ultraviolet light are capable of transporting such information from the body to the cloth by their energy, intensity, and direction. Charged particles, such as protons or electrons, have the same capability. In fact, of the various means of transporting information from one location to another, such as sound waves, electron flow in wires, diffusion of molecules, etc., only radiation could have transported the information from the body to the cloth that is required to form the good resolution image on the Shroud (Ref. 5). This radiation could have consisted of charged particles, such as protons or electrons, and photons of electromagnetic radiation such as infrared, visible, or ultraviolet light.

3. How was the Image Formed?

As discussed above, the evidence indicates that the dead body of a crucified man was wrapped in the Shroud, that the image was formed by the body, and that this required the transfer of the information from the body to the cloth. This information had to define the appearance of a naked crucified man because that is what the image is. This information could only have come from the body and could only have been transported from the body to the cloth by radiation. We next look at the details of the image. This will establish the requirements that must be met by the process that formed the image.

Figure 2 shows the 3-to-1 Herringbone weave of the Shroud and shows certain fibers that have been discolored. It is these discolored fibers that make the image of the crucified man. Yet as you get close to the fabric, as in Figure 2, you cannot see the image. In a painting or a photograph, you can see the details of the image better as you get closer to it, but with the Shroud, you must be several feet back from the cloth to see the image. The discolored fibers appear in groups with some areas of the threads discolored and other areas not discolored. This mottling effect of the discolored fibers is an aspect of the image that needs to be explained. It should be noted that the discolored fibers are only on the surface of the thread.

Research by STURP determined where the discoloration is located on the threads. Figure 3 shows a cross section of a linen thread with 150 fibers in it, though a linen thread can contain 200 or more fibers. It shows that: 1) of the fibers on the side of the thread that was facing the body, only the top one or two layers of fibers are discolored, 2) there is nothing clumping the fibers together so the image could not be due to paint, dye, or stain, and 3) there is no evidence of capillarity from one fiber to another. How could only the top two layers of fibers in a thread have been discolored without clumping or capillarity? This diagram also shows that there may be some fibers discolored on the opposite side of the thread, on the side of the cloth facing away from the body, depending on whether a real image can be seen on the opposite side of the cloth that was on the outside of the wrapped configuration. There is disagreement on whether there is such an image on the outside of the cloth.

The extreme superficiality of the discoloration is not only indicated by only the top one or two layers of fibers in a thread being discolored, but also by the location of the discoloration in a discolored fiber. A linen fiber is about 15 microns in diameter, with a micron being a millionth of a meter, which is equal to a thousandth of a millimeter (1 micron = 0.000001 meter = 0.001 mm). This diameter of a linen fiber is about one-fifth the diameter of a human hair. The straw-yellow to sepia color is located only in the outer 0.4-micron thick surface layer around the circumference of the fiber, as shown in Figure 4, with the inside of the fiber not discolored. The thickness of this discolored layer is probably more accurately described as 0.2 ± 0.2 microns.

The cause of the discoloration in this thin layer is apparently due to a change in the structure of the atoms in the cellulose. Carbon atoms have two electrons in their inner orbit and four electrons in their outer orbit. Each of these four outer orbit electrons is normally bound to one other atom in cellulose, which causes the carbon atom to vibrate in a certain way. But in the thin discolored layer, some of the carbon atoms are only surrounded by three other atoms. This means that of the four outer orbit electrons, one electron is bound to one adjacent atom, another electron is bound to a second adjacent atom, but two electrons are bound to the third adjacent atom. This change from a single electron bond to a double electron bond causes the carbon atom to vibrate differently so that we see a different color reflected from it. What could cause such a change from single electron bonds to double electron bonds in such a thin layer in a fiber to produce the image of a crucified man?

Remember that it is the pattern of these discolored fibers that form the good resolution image of the face, with the image being a negative image that contains 3D information. The pattern of discolored fibers also formed the entire front and back images of the body (Figure 1). How could the fibers have been discolored in the precise pattern to create these images? It should be noticed that the mechanism that formed the good resolution images of the front and back of the body did not form images of the sides of the body or the top of the head.

Three things are required to form the image. 1) There must be a process or mechanism to discolor the fibers. 2) Energy must be provided to drive the discoloration mechanism so that it would cause some of the carbon atom to change from single to double electron bonds. 3) Information must be provided to the discoloration mechanism to control which fibers are discolored and the length of that discoloration so that the image could be formed. No image could have been formed without the proper information to control the discoloration mechanism. The required information is that which defines the appearance of a crucified man, for that is what the image is. This information could have only come from the body. According to the hypothesis advocated here, the radiation from the body could have delivered both the energy and the information required to form the image (Ref. 5).

A paper published in the March 20, 2019; issue of *Applied Optics* has produced the very best image of the face on the Shroud (Ref. 6). This image was produced by radiation controlled by information, as advocated above. To produce this image, a laser was used that emitted a femtosecond pulse of infrared light. A femtosecond is an extremely small fraction of a second: one femtosecond = 10^{-15} second = a millionth of a billionth of a second. Previous experiments (Ref. 7-11) with an ultraviolet laser indicate that the laser pulse must be extremely rapid to

produce the degree of superficiality that exists on the Shroud with only the top one or two layers of fibers discolored.

The above evidence can be assembled into a proposed hypothesis to explain how the image was formed (Ref. 12). The dead body of a crucified man was wrapped in the Shroud. This body caused both the blood and the image on the Shroud. The image was formed by something that flowed from the body to the cloth across the air gap between the two:

1. As the body was wrapped in the Shroud, the cloth would have been touching the tip of the nose but not the side of the nose at the nostrils, yet there is a smooth gradation of discoloration down the nostrils. This means that the discoloration could not be the result of contact with the cloth. It had to be caused by something that flowed across the air gap between the body and the cloth.
2. Upper fibers and threads in the image shield lower ones from discoloration. This implies that something flowed from the body to the cloth that was prevented from getting to the lower fibers and threads by the upper ones.
3. We can see the image because the information that defines the appearance of a crucified man has been encoded into the pattern of discolored fibers in the image. This information had to be transported from the body to the cloth to control the discoloration mechanism that formed the image. Radiation is the only realistic option to transport this information (Ref. 5). Radiation, both particles such as protons and electrons and electromagnetic radiation such as infrared, visible, and ultraviolet light, can transport information by their energy, intensity, and direction.
4. There is 3D information in the image. This 3D information is related to the vertical distance of the air gap between the body and the cloth, with no discoloration of the fibers if this air gap is over about three of four centimeters. This 3D information effect would result if whatever flowed from the body to the cloth diminished as it traveled across the air gap. Radiation emitted in the body would naturally diminish as it went across the air gap due to absorption and scattering in the air. Particle radiation can also decrease due to decay.

Based on the above evidence, the image formed when an extremely rapid intense burst of radiation was emitted from the body. This radiation transported the energy and information to the cloth that was required to form the image. It had to be an extremely rapid burst to produce the superficiality of the image. This radiation probably consisted primarily of charged particles such as protons and electrons, although electromagnetic radiation such as infrared, visible, and ultraviolet light could also have been involved. Highly penetrating radiation such as neutrons, X-rays, and gamma rays were not significant contributors to the image formation. If they had been, then there would be an image with a similar intensity on the opposite side of the cloth, i.e., on the outside of the wrapped configuration, which is not true for the Shroud.

Since there would have been no lens between the body and the cloth, the radiation had to be emitted vertically collimated as the body lay horizontal in the tomb. “Vertically collimated” refers to the radiation being emitted exactly vertically up and vertically down from the horizontal body. This is necessary so that each point on the front and back images received radiation, and hence information, from only one point on the body. If the radiation was not vertically collimated relative to the horizontal body, then each point on the cloth would have received

radiation, and hence information, from multiple points on the body. This would have caused confusion of the information reaching each point on the cloth, which at best might have caused discoloration on the cloth but no image. The vertical collimation of the radiation also explains why there are no images on the Shroud of the sides of the body or the top of the head.

This extremely rapid intense burst of charged particles would have created a very high electrical charge on the cloth in a very short time span, which, if rapid and intense enough, would have caused an electrical discharge from the high points of the fibers facing the body. This electrical discharge from the fibers would have involved an extremely high electrical current in the fibers, with the electrons flowing primarily near the outer circumference of the fibers as a high electrical current normally does in a conductor. This would have produced extreme heating around the outer circumference of the fibers, which could have damaged the atomic structure of the cellulose around the outer circumference of the fibers, just where the fibers are discolored. The static discharge could also have formed ozone, which could also have damaged the cellulose around the circumference of the fibers.

The mottled appearance of the discolored fibers, with some areas on the threads discolored and other areas not discolored, can be explained as a "lightning rod" effect. When a thunder cloud passes over an area of level ground containing many lightning rods, lightning will strike where the distance between the cloud and a lightning rod is a minimum. The lightning between the cloud and the tip of the lightning rod will produce a very significant electrical flow in the ground and in the clouds so that the surrounding area in the ground and in the clouds is discharged. As a result, lightning will probably not strike in the immediate area again. The same principle holds for the electrical discharge from the top fibers of the threads in the Shroud, resulting in areas of the thread that are discolored and other areas that are not discolored. This effect, as well as scattering of the radiation by the air between the body and the cloth, would cause some loss in the resolution of the image, as is seen on the Shroud.

Both the electrical heating and the possible ozone could damage the atomic structure of the cellulose in the outer circumference of the fibers. It is believed that with the passage of time, possibly combined with exposure to ultraviolet light in sunlight, this region of damaged cellulose in the outer circumference of the fibers became discolored by an oxidation-dehydration process that causes some of the single electron bonds of the carbon atoms in the cellulose to be changed to double electron bonds. This change in the electron bonding of the carbon atoms causes the appearance of the straw-yellow or sepia color in the image. But this process was very selective in that it created the image of a crucified man, based on the information deposited on the cloth. If this scenario is correct, then the image may not have formed immediately after the burst of radiation from the body but could have perhaps taken weeks, months, or years to form. The attractiveness of this proposal for image formation is that it can explain all the characteristics of the image: a negative image on the inside of the wrapped configuration that contains 3D information, extreme superficiality of the image, color due to a change in the electron bonding of carbon atoms in the cellulose, mottling of the threads, and the upper fibers and threads shielding lower ones from discoloration.

4. What is the Date of the Shroud?

The dating of the Shroud is a common objection to its authenticity. We will now discuss the history of the Shroud and why it does not date to 1260-1390 AD, which was the range obtained by the 1988 carbon dating of the Shroud. The history of the Shroud is summarized in Figure 5.

It is often said that the Shroud only dates to about 1355 AD. A correct understanding of this issue is that the continuous history of the Shroud only goes back to about 1355 or 1356 when it was shown in Lirey, France, as the burial cloth of Jesus. However, good evidence indicates the Shroud was at certain locations long before 1355, though its route between these locations is not known. Several items found on the Shroud indicate it was in Jerusalem: 1) DNA from the area of Israel, 2) pollen unique to the Jerusalem area, and 3) a small chip of limestone identified as "Jerusalem limestone" based on its impurities. After Jerusalem was destroyed in 70 AD, Antioch on the Mediterranean coast became the center from which the Christian message spread (Acts 11:26, 18:23). As a result, Jesus's burial cloth may have been taken to Antioch at some point in time. The apostle Paul may have used it for apologetic purposes in Galatia (Gal. 3:1). Tradition indicates it was taken to Edessa, Turkey, probably in the second century, and was later brought into Byzantium, which was later called Constantinople and now Istanbul. It was then taken to Lirey, France, transported across France, and arrived in Turin, Italy, in 1578. Figure 5 shows the route from Lirey to Turin in a solid line because this route is historically well attested, but the routes from Jerusalem to Edessa to Constantinople to Lirey are in dashed lines for the routes are not known.

In Galatians 3:1, Paul says, "You foolish Galatians, who has bewitched you, before whose eyes Jesus Christ was publicly portrayed as crucified?" (NASB). The NIV uses the phrase "clearly portrayed". Many translations use the word "pictured". Most translations and commentaries assume Paul had preached to them so clearly and forcefully about Christ's crucifixion it was as though he had shown them a picture of Christ's crucifixion. Thus, they take it in a figurative sense, but it can also be taken in a literal sense, i.e., that Paul held up an object that publicly and clearly pictured Christ's death before their "very eyes" (NIV). If this literal sense is what Paul meant, then what better object to hold up before their "very eyes" than Jesus' burial cloth with His blood on it and possibly with His image on it? The Greek word at issue in Gal. 3:1 is "proegrapha", from which we get the English word "graphic". It can be translated as portrayed, pictured, placarded, or signboarded. These first two words allow for, and the last two words emphasize a physical object on which a message is contained that is to be communicated in a public place. If Paul had held up Jesus' burial cloth to communicate the certainty and meaning of Jesus' death, it should have had a dramatic effect on the Galatians. We should allow for this as a possibility.

There is good evidence that what we call the Shroud of Turin was in Constantinople at least up until 1204 when the city was sacked during the fourth crusade. It was probably brought into Constantinople about 574 AD as a cloth called the "Image of God Incarnate". This is because Byzantine coins were minted containing the image of the face starting in 692 AD. The French crusader Robert de Clari reported that Jesus' burial cloth "raised itself upright" every Friday in the My Lady Saint Mary Church in the Blachernae district in Constantinople. It probably rose out of a box via some type of mechanism. But the best evidence the Shroud of Turin was in

Constantinople is the Hungarian Pray Codex or Manuscript discovered by György Pray in 1770 and dated to 1192-1195 AD. To understand this manuscript, it is necessary to first understand the so-called "poker holes" on the Shroud. Four sets of four holes in an L-pattern can be seen in each quadrant of the Shroud (Figures1 and 4). These holes were evidently formed when the Shroud was folded in half on the short side and then folded in half again on the long side. These holes have a characteristic pattern: three holes in a straight line and a fourth hole at a 90-degree angle to the straight line. Perhaps something hot, like burning coals, fell onto the folded cloth, burning through each layer of the cloth in sequence. Holes in this same pattern also appear on a copy of the Shroud painted in 1516 AD, so these holes predated the fire in 1532.

The Hungarian Pray Manuscript is the oldest manuscript in the Hungarian language. It is kept in the National Szechenyi Library in Budapest. One page of this manuscript, shown in Figure 7, contains two colored drawings. The upper scene shows three men, probably the apostle John, Nicodemus, and Joseph of Arimathea, preparing the body of Jesus for burial. The hands on Jesus' body do not show the thumbs, consistent with the Shroud of Turin. The man on the right appears to be holding a length of cloth in one hand.

The lower scene (Figure 8) is after Jesus' resurrection. It shows an angel on the left and three women on the right with Jesus' empty burial cloth in front of them. The top piece of this cloth is folded back so the blood, represented inside crosses, can be seen on the inside of the cloth. It can be identified as Jesus' burial cloth by the stair-step pattern on the top cloth, representing the three-to-one herringbone weave of the Shroud of Turin. Notice this pattern is on the right and left sides of this top cloth, but this pattern is broken in between. When you look at it carefully, you can see what appears to be a knife at the top edge of the top cloth. This knife appears to have been used to cut something from the top cloth, leaving a hole in the herringbone pattern. The left-most woman has a more prominent halo, or nimbus, around her head, indicating her prominence among the three women. Most surprising, on her right arm can be seen a side view of a man's head probably with a beard. Evidently, the angel has cut the image of the man's face/head from the top portion of the cloth and given it to the woman, who is probably Mary. This indicates the top part of this cloth contained the image of the face/head. This indicates the bottom picture is depicting Jesus' burial Shroud, which contained an image of Jesus' face/head.

A closer look at the bottom picture shows that the Hungarian Pray Manuscript, which is dated to 1192-1195, contains the same hole pattern as the Shroud of Turin. This proves that the Hungarian Pray Manuscript is depicting the Shroud of Turin, so that the Shroud was in existence prior to the carbon date of 1260-1390 AD. Since the one sigma uncertainty on the uncorrected carbon date is 31 years, the difference between the carbon date and the Hungarian Pray Manuscript (1260 – 1195 = 65 years) is 65 / 31 = 2.1 sigma below the carbon date range of 1260-1390. Since the range of 1260-1390 is a two-sigma range (Ref. 13), and the date for the Hungarian Pray Manuscript (1192-1195) is an additional 2.1 sigma lower, it is more than four-sigma below the carbon date. The normal acceptance criterion is two-sigma, so the possibility this difference (1260 - 1195 = 65 years) could occur due to a random measurement error should be rejected. This means that the carbon date of 1260-1390 should be rejected based on the Hungarian Pray Manuscript dating to 1192-1195.

Some have tried to argue this bottom picture does not show Jesus' burial cloth but instead shows a sarcophagus in which Jesus was buried. A sarcophagus is a box-like funeral receptacle for a corpse, usually carved in stone, and usually displayed above ground. Much of iconography by the middle ages had replaced Jesus' burial tomb with a sarcophagus. In this explanation, the bottom cloth is sometimes explained as the bottom box of the sarcophagus, and the top cloth is said to be the lid of the sarcophagus with Jesus' burial shroud crumpled on the lid to the right of the angel's foot. This explanation is used to eliminate the evidence for the Shroud of Turin's existence long before the carbon date of 1260-1390. This explanation cannot be correct because it fails to explain several features of the picture:

- The lower and upper cloths show no thickness, contrary to the clear three-dimensionality of the box and usually also of the lid for a sarcophagus in iconography.
- The upper cloth appears as though it could be attached to the lower cloth at the far-left side of the picture, contrary to the lid being clearly separate from the sarcophagus box in iconography.
- The bottom cloth in the picture is covered with crosses of an orange color depicting Jesus' blood. In iconography, the inside of the box shows no blood.
- The four holes, three in a straight line and the fourth at a 90-degree angle, is a very unusual pattern and is perfectly explained by the holes on the Shroud of Turin but has no explanation if this is the lid of a sarcophagus.
- The stair-step pattern on the top cloth is an excellent representation of the 3-to-1 herringbone weave of the Shroud but has no adequate explanation if this is the lid of a sarcophagus.
- The knife laying on the top cloth and the image of the face/head held by the woman on the left, presumably Mary, have no adequate explanation if this is a sarcophagus. If this picture shows Jesus' burial cloth instead of a sarcophagus, then the image of the head was evidently cut out of the top cloth with the knife, possibly by the angel, and given to Mary. This means the image of the face/head was on the top cloth as on the Shroud of Turin.

Some have tried to argue this is not the same as the Shroud of Turin because the L-shaped pattern of four holes has been rotated by 90-degrees relative to the pattern on the Shroud, but this reasoning is not adequate because 1) this unusual pattern of circles would have no reason to be included in the picture if it were not depicting the same cloth as the Shroud of Turin, 2) perhaps the artist had not seen the Shroud himself or had seen it but had forgotten exactly how the angle of the L-shaped pattern of holes was oriented, and 3) there are other examples in the picture where the artist appears to be somewhat geometrically challenged. The conclusion is the Hungarian Pray Manuscript is depicting what we now call the Shroud of Turin, which proves the Shroud existed in Constantinople long before the carbon date of 1260-1390, which disproves this carbon date.

There are many reasons the Shroud of Turin and its image could not be from 1260 to 1390 AD, as determined by the 1988 carbon dating of the Shroud. An artist or forger in 1260-1390 would not:

- Be able to create a negative image without pigment, chemicals, liquid, or scorch that contains 3D information related to the body-to-cloth distance.

- Be able to produce fiber discoloration by a change from single to double electron bonds in cellulose that produce the image of a crucified man.
- Know the details of first-century flogging and crucifixion.
- Know to put the nails in the wrists with thumbs folded under, contrary to paintings from the Middle Ages.
- Know or be able to add pollen to the Shroud that is unique to Jerusalem.
- Know or be able to add pollen from a plant with long thorns around the head on the Shroud.
- Know to put a microscopic amount of dirt in abrasions on the nose and one knee.
- Know to put a microscopic chip of Jerusalem limestone onto the Shroud.
- Know or be able to put bilirubin and nanoparticles of creatinine and ferritin into the blood that indicate the body had gone through torture.
- Know to use a unique stitch to attach the 3.5-inch side piece to the main Shroud that was very similar to a stitch found only at Masada, which was destroyed in 73 to 74 AD.

Section 6C of Ref. 1 lists 14 date indicators for the Shroud. Thirteen of them are consistent with the first century and contradict the 1988 carbon dating to 1260-1390. Only the carbon dating is inconsistent with the first century. The next section explains how the 1988 carbon dating of the Shroud could have produced a faulty conclusion.

5. What About the 1988 Carbon Dating?

In 1988, samples were cut from the Shroud of Turin for carbon dating. The result of this process was a date range of 1260 to 1390 AD. The consensus of Shroud researchers is this date is faulty and should be rejected. This section explains how carbon dating could produce a date of 1260-1390 AD for the Shroud when other evidence indicates it is from the first century.

A strip of linen about 1.2 x 8 cm was cut from the Shroud by Giovanni Riggi on April 21, 1988. Figure 10 shows the Shroud as it was cut. This strip was used to produce samples that were sent to three laboratories in three different countries for carbon dating. This strip was cut from the bottom corner of the cloth next to the front image (Figure 11). It was cut off parallel to the seam that attaches the side strip to the main Shroud cloth, and adjacent to one corner that had torn off or was possibly cut off at some point in the past, thus showing only the backing cloth that was attached to the Shroud in 1534. Samples for three laboratories were cut from this 1.2 x 8 cm linen strip (Figure 12). First, a sample, designated A1, was cut from the right end of this linen strip. It was to be sent to the dating laboratory in Tucson, Arizona. Samples were then cut for dating laboratories in Zurich, Switzerland, and Oxford, England. These samples, designated "Z" and "O", were cut in sequence along the linen strip. These cuts were intended to provide each of the laboratories with samples of at least 50 mg, but it was found that sample A1 was only about 40 mg whereas samples Z and O were slightly over 50 mg. As a result, it was decided to remove a second sample, designated A2, to also be sent to the laboratory in Tucson, Arizona. The laboratories cut subsamples from the samples sent to them for carbon dating, except the laboratory in Tucson did not cut subsamples from sample A2 but rather put it into a vault in Turin, Italy, where it is to this day.

To assure proper measurement results, three standards were also dated at the same time as the Shroud samples. These standards were cloth samples taken from clothing of known dates based on their history. The measured dates and measurement uncertainties, and the analysis of the data for the Shroud subsamples and the standards were reported in the British journal *Nature* in 1989 (Ref. 13). The title is "Radiocarbon Dating of the Shroud of Turin". Twenty-one authors are listed as author for this paper with the first author being P. E. Damon, so this paper is commonly called "Damon, et. al."

Carbon dating of a sample does not measure the date directly. It measures the ratio of carbon-14 (C^{14}) to C^{12} in the sample and then calculates a date for the sample based on the C^{14} atoms in the sample decaying with a half-life of 5730 years whereas C^{12} atoms do not decay. According to Damon, et. al. (Ref. 13), the average date for the Shroud samples from the three laboratories (Tucson, Zurich, and Oxford) is 1260 ± 31 AD. This is the raw or uncorrected value. When this value was corrected for the changing concentration of C^{14} in the atmosphere, a date range of 1260 to 1390 was obtained. This is claimed to be a two sigma or 95% range. This means there should be a 95% probability the true date for the Shroud is between 1260 and 1390 AD. Based on this, Damon, et. al. states in both the abstract and the conclusion that "These results provide conclusive evidence that the linen of the Shroud of Turin is mediaeval." When the raw data for the 1988 dating of the Shroud was finally obtained from the British Museum in 2017 (Ref. 14), it was learned that one of the peer reviewers of this paper (Professor Anthos Bray) recommended this concluding statement be removed from the paper, probably because it was not justified by the analysis of the data. However, *Nature* published this paper without removing this concluding statement, thus ignoring the recommendation of Professor Bray.

The proposed explanation for the Shroud being carbon dated to 1260 ± 31 AD is the neutron absorption hypothesis (Ref. 15), first proposed by Dr. Thomas Phillips (Ref. 16) then of the Harvard Laboratory. This hypothesis proposes that if neutrons were included in the burst of radiation that caused the image, then some of the neutrons (about one in a million) would have been absorbed in the trace amount of nitrogen-14 (N^{14}) in the Shroud to produce new C^{14} atoms by the [N^{14} + neutron → C^{14} + proton] reaction. This could shift the carbon date forward by thousands of years, depending on the location on the cloth, thus explaining the 1988 carbon dating.

Based on this hypothesis, nuclear analysis computer calculations were performed using the MCNP (Monte Carlo N-Particle) nuclear analysis computer code. MCNP was developed over many decades at the Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. The accuracy of this computer code has been verified and validated for use on United States NRC (Nuclear Regulatory Commission) and DOD (Department of Defense) projects by comparison of thousands of nuclear experiments with MCNP calculations. To understand the 1988 carbon dating of the Shroud, MCNP was used to model a human body using simple geometrical volumes surrounded by a linen cloth on the back bench in a limestone tomb as it would have been constructed in first-century Jerusalem. It was assumed neutrons were included in the burst of radiation that was emitted in the body that formed the image. It was also assumed these neutrons were emitted uniformly (homogeneously) in the body. MCNP was used to calculate the distribution of neutron absorption in the trace amount of N^{14} in the cloth, which would have produced new C^{14} in the Shroud, which would have shifted the carbon date forward.

This is because carbon dating is based on measurement of the ratio of C^{14} to C^{12}. If new C^{14} were produced in the threads of the Shroud, then the carbon date would have been shifted forward.

The distribution of the carbon dates calculated by MCNP is shown in Figure 13. This curve is for locations on the dorsal (back) image along the centerline of the body, i.e., along the backbone, from the feet at the left to the head at the right. On the x-axis, the zero value is at the mid-height of the body. This curve is normalized to the laboratory's average value of 1260 AD at the second point from the left. This curve shows that according to the hypothesis of neutrons being emitted uniformly in the body, the calculated carbon dates are predicted to be quite variable by position with a maximum value of about 8500 AD on the back image below the center of the body mass, if the usual equations are used. About 80% of locations on the Shroud are predicted to date to the future. Such dates to the future result when the usual equations are used to calculate a date from the C^{14}/C^{12} ratio and there is more C^{14} present in the sample than ought to be present in a living plant. The most important point is that MCNP predicts a very significant slope in the carbon date at the second point from the left. This MCNP calculated slope in the carbon dates is about the same as the slope measured by the three laboratories, Shown in Figure 14! This agreement between the calculated slope (Figure 13) and the slope experimentally determined by the three laboratories (Figure 14) supports the validity of the neutron absorption hypothesis.

The average dates from each laboratory (Oxford on the left, Zurich in the middle, and Tucson on the right) and the measurement uncertainties are plotted in Figure 14. The y-axis is the carbon date calculated from the measured C^{14}/C^{12} ratio. The x-axis is the distance of the center of the sample from the bottom edge of the Shroud, with the bottom edge of the cloth shown in Figures 1 and 11. The red circle in Figure 14 is the measured value, i.e., the date calculated from the measured C^{14}/C^{12} ratio of the sample, and the vertical bar through each measured date is the one-sigma measurement uncertainty of the date. The “one sigma measurement uncertainty” is a necessary consideration because each carbon date is not a single point but is a probability distribution caused by uncertainties in the measurements. This probability distribution is called a normal or Gaussian distribution. It is often also called a bell curve. Each date plotted on Figure 14 indicates the peak of the probability distribution and the vertical red bar through each date indicates the width of the probability distribution. The length of each red bar is the one-sigma width of the probability distribution, which means that there is a probability of about 68% that the true value falls within the range of the vertical red bars. The question is whether the constant value at 1260 AD (horizontal black dashed line at 1260 in Figure 14) that was assumed in Damon, et. al. (Ref. 13) is an acceptable fit to the three measured dates with their associated uncertainties, or whether the red dashed line with a slope of about 36 years per centimeter (cm) is the appropriate fit to the data. Notice that the black line only goes through the one-sigma uncertainty of one date (Zurich), whereas the red line goes through the one-sigma uncertainty of all three dates.

If the black line is an acceptable fit to the three measured dates with their associated uncertainties, then the measured carbon date would not have to be a function of the distance from the bottom of the Shroud. This would be the case, for example, if the measurement uncertainties

indicated by the vertical red bars were three times larger than shown in Figure 14. If this were the case, then 1260 ± 31 AD could be the true value for the uncorrected date.

On the other hand, if the measurement uncertainties were one-third as large as shown in Figure 14, then it would be easily recognized that the horizontal black line at 1260 would not be an appropriate fit to the data so that the red line would be selected as the appropriate fit to the data. This would imply that the measured carbon date depends on the location on the Shroud. But if this is true, then an unidentified factor must be present to cause this dependence on location, so that the measured dates could be significantly different than the true date for the Shroud. If this were the case, then the measured dates for the Shroud should be rejected. Thus, whether 1260 ± 31 AD should be accepted or rejected for the uncorrected date of the Shroud depends entirely on the magnitude of the measurement uncertainties.

But in the statistical analysis of the data in Damon, et. al., the measurement uncertainties were assumed to be underpredicted, which allowed them to be ignored. Thus, the crucial item to determine whether the measured values should be accepted or rejected, which is the measurement uncertainties, were ignored. This was done evidently because there were problems in the statistical analysis that should have caused them to reject the 1260 date for the Shroud (Ref. 17, 18, and 19), and because their main goal was to validate the accuracy of their small sample dating technique. Dating the Shroud was merely a means to that end. But when they ignored the measurement uncertainties in Damon, et. al., they could no longer perform a statistical analysis to prove the variation of the measured values was consistent with the measurement uncertainties, without the need for an unidentified factor to explain the variation of the measured values. Thus, they could not assure that no unidentified factors had affected the measurements of the samples. The C^{14}/C^{12} ratios of the samples could have been accurately measured within the stated uncertainties in Damon, et. al., but the calculated dates could have been very different from the true date for the Shroud because something had altered the C^{14}/C^{12} ratios in the samples, such as neutron absorption creating new C^{14} in the samples.

The chi-squared statistical analysis technique can be used to calculate the probability that the black line at 1260 in Figure 14 is an acceptable fit for the measured dates with their measurement uncertainties. The result of this calculation is that if the carbon date is the same for every location on the Shroud, then the probability of obtaining a variation in the 1988 Shroud samples at least as large as was obtained is only 1.4% (bottom left corner of Table 6 in Ref. 18 and Table 4 in Ref. 21). Since the usual acceptance criteria is 5.0%, the uncorrected date for the Shroud of 1260 ± 31 should be rejected from necessarily being the true value. And if the 1260 ± 31 date should be rejected, then the range of 1260-1390 should also be rejected because it was obtained starting from the 1260 ± 31 date.

In Figure 15, the black line shows how C^{14} would decay. Before the flax plant was cut down to make the linen, which in Figure 15 is assumed to take place at time zero on the x-axis, the C^{14} already in the plant would be decaying but the plant is also taking in new carbon from the atmosphere in photosynthesis. This would bring in new C^{14} into the plant so an equilibrium amount of C^{14} would be established. But after death of the plant, no new C^{14} would be brought into the plant so the total C^{14} in the plant would decrease with a half-life of 5730 years, as shown in Figure 15 to the right of the zero-time point. Those who carbon dated the Shroud samples in

1988 evidently assumed there was no reason to assume anything unusual about this linen cloth so the black line could be used for dating. When they measured that the C^{14}/C^{12} ratio had decreased from 100% to 92% of its value when the plant was alive, they would have moved horizontally from 92% on the y-axis over to the black line, and thus implied the samples were from 1260 AD. But according to the neutron absorption hypothesis, neutron absorption increased the C^{14} at the sample location by about 16% in a small fraction of a second, as shown by the vertical section of the red line. This red line would then have decreased with a 5730-year half-life, as shown on the graph. When they measured their 92% value, they should have moved horizontally over to the red line, which would have given them a date of about 30 AD. Thus, the root cause of their dating the Shroud to 1260 AD resulted from their assumption that the Shroud was a normal piece of linen, so that nothing unusual could have happened to it. But if Jesus' resurrection were a true historical event, then we would have no idea of the effects of such an event on his burial Shroud.

There are two ways to test the neutron absorption hypothesis: the predicted distribution of carbon dates on the Shroud and the predicted production of long half-life isotopes in the Shroud and limestone of the tomb. The MCNP nuclear analysis computer calculations predict different carbon dates for every location on the Shroud based on the calculated neutron distribution in the tomb. These predicted dates, and the change in the C^{14}/C^{12} ratio are shown in Figure 16. A positive change in the C^{14}/C^{12} ratio relative to the C^{14}/C^{12} ratio when the plant was alive, when used in the normal equations for carbon dating, produces a predicted date to the future. The production of long half-life isotopes in the Shroud and limestone in the tomb have yet to be calculated.

The first step in the scientific method used to explain any phenomenon is to develop a hypothesis that is consistent with what is known to be true about the phenomenon. We know four things about carbon dating as it relates to the Shroud of Turin:

1. In 1988, samples from the corner of the Shroud were dated to an average of 1260 ± 31 AD, uncorrected.
2. The slope of the average values from the three laboratories is about 36 years per cm, as indicated in Figure 14.
3. The range of dates for the 16 subsamples is 1155 to 1410 AD (Table 6 of Ref. 18).
4. The Sudarium of Oviedo, which is believed to Jesus' face or head cloth, was carbon dated to 700 AD.

The only hypothesis consistent with all four of these criteria is the neutron absorption hypothesis, so it should be accepted as having the highest probability of being true. A hypothesis cannot be true if it contradicts any of these criteria. The hypothesis that the image on the Shroud was produced by an artist or forger could be consistent with #1, and with #4 if it is assumed the Sudarium of Oviedo was also produced by an artist or forger, but it is difficult to conceive how this hypothesis could be consistent with #2 and #3. The invisible reweave hypothesis could be consistent with #1 and #2, if it is assumed to have the correct ratio of new to old fabric as a function of location on the samples. The invisible reweave hypothesis appears to be contrary to criteria #3. This is because cutting of the subsamples from the samples provided to the three laboratories would likely have been a random process. This means at least some and most likely four of the 16 subsamples should have dated only old material, which should date to about 30

AD, and at least some and most likely four of the 16 subsamples should have dated only new material, which should date to about 1530 or so. Yet none of the subsamples were dated to either about 30 or 1530 AD. Also, regarding #4, an invisible reweave on the Shroud would not have altered the carbon dating of the Sudarium. Eight objections to the invisible reweave hypothesis are listed in section 2 of Ref. 15.

6. The Blood on the Shroud

The first seven decades of Shroud research were concerned primarily with issues related to the blood, including why the blood that would have dried on the body with no underlying wounds, is now on the Shroud. This is mysterious because dried blood does not soak into cloth, and it would not produce the characteristics of the blood now on the cloth.

Though no calculations have been done on it, the hypothesis of an extremely rapid intense burst of radiation emitted in the body raises an interesting possibility. It is well known that particles that have mass also have momentum as they move. It is also true that electromagnetic radiation such as infrared, visible, and ultraviolet light have momentum. When this momentum from either particles or electromagnetic radiation is absorbed and thus transferred to an object, it can cause it to move. This is referred to as radiation pressure and has multiple applications from Crookes radiometer (also known as a light mill) to a solar sail to propel a spacecraft. The point is that a burst of radiation emitted within the body, as hypothesized here, if sufficiently rapid and intense, and if vertically collimated both up and down, could force the blood off the body, accelerate it vertically away from the body without scattering it, and thrust it onto the cloth. The result would be the blood as we now find it on the Shroud.

Other mysteries related to the blood are the following. Why is the blood still a reddish color when blood exposed to air quickly turns dark brown to black, why are there no discolored fibers of the image under the blood, and why does the image of the face appear to have been encoded onto a flat surface?

Based on recent experiments by Kelly Kearse, high quantities of bilirubin in the blood will not cause it to retain a reddish color. Previous experiments by Carlo Goldoni (Ref. 20) indicate neutron absorption in blood followed by exposure to ultraviolet in sunlight can cause blood to retain a reddish color. This evidence was not well documented and should be confirmed. If neutrons were included in the burst of radiation that caused the image, as in the neutron absorption hypothesis, then they would have been absorbed in the blood to cause its reddish color to persist, as well as in the N^{14} to produce new C^{14} in the fibers to shift the carbon date. If momentum and thus energy in the radiation was deposited in the blood to force it off the body and onto the Shroud, there may have been insufficient energy remaining in the radiation to discolor the fibers under the blood, thus explaining why there is no image under the blood. Electrostatic forces involved in this process may also explain why the image looks as if it was encoded while the cloth was flat above the body, with no distortion of the image due to the cloth wrapping around the body.

7. Conclusion

By following the evidence where it leads, apart from religious or naturalistic presuppositions, a hypothesis was developed to explain the mysteries of the Shroud including the image, date, and blood. This hypothesis is that an extremely rapid intense burst of radiation was emitted within the dead body of a crucified man as it was wrapped within the Shroud. This radiation traveled from the body to the cloth where it deposited the energy required to drive the discoloration mechanism, and the information required to control the mechanism that discolored the fibers to form the image. To form the good resolution images of the front and back of the body, without lenses between the body and the cloth, the radiation had to be vertically collimated both vertically up and vertically down from the horizontal body as it lay in the tomb. This would also explain why there are no side images of the body on the Shroud.

The radiation that caused the image was probably charged particles such as protons and electrons and possibly electromagnetic radiation such as infrared, visible, and ultraviolet light, but not penetrating radiation such as neutrons, X-rays, or gamma rays. The charged particle radiation very rapidly produced an extremely high electrical charge buildup on the cloth, which produced an electrical discharge from the top fibers facing the body. This produced an extremely high electrical current flow, which produced extreme heating, which damaged the thin region, less than 0.4 microns thick, on the circumference of the fibers. This led to discoloration of the fibers that formed the image. The possible production of ozone might also have led to a chemical attack on this thin outer region. This can explain the superficiality of the image, the 3D information in the image, mottling of the discolored fibers, and discoloration caused by a change in the electron bonding of the carbon atoms in the cellulose.

Neutrons present in the burst of radiation would have been absorbed in the trace amount of N^{14} in the cloth to produce new C^{14} in the Shroud. This would have shifted the carbon date forward by up to thousands of years, depending on the location on the cloth, thus explaining the 1988 carbon dating of the Shroud. The neutron absorption hypothesis can be tested using the predicted distribution of the carbon dates on the Shroud, and possibly by detecting long half-life isotopes in threads from the Shroud and in limestone from the tomb. The neutrons would have also been absorbed in the blood, which may have led to the blood retaining a reddish color. The extremely rapid intense burst of collimated radiation could have thrust the dried blood off the body onto the cloth. In transferring momentum and thus energy to the blood to move it, the remaining energy in the radiation might have been insufficient to cause discoloration of the fibers, so that no image would have been created under the blood. The electrostatic forces involved in this process may be helpful to understand why the top cloth appears to have been flat above the body since there appear to be no distortion effects on the image from the cloth wrapping around the body.

Thus, this hypothesis is attractive because of its explanatory power. It explains the mysteries of the Shroud regarding the image, the carbon dating, and the blood. Specifically, it can explain:

1. Why the image is on the side of the cloth that was facing the body,
2. Why the image has a good resolution, without images of the sides of the body or the top of the head.

3. Why there is an image where the cloth would not have been touching the body,
4. Why the front and back images are of equal intensity,
5. Why the image is a negative image,
6. Why the image contains 3D information related to the vertical distance of the cloth from the body,
7. Why only the top one or two layers of fibers are discolored in a thread,
8. Why only a very thin outer region less than 0.4 microns thick on any fiber is discolored,
9. Why the electron bonding was changed from single to double electron bonds for carbon atoms that were already in the cellulose molecules to cause the discoloration,
10. Why upper threads and fibers shield lower ones,
11. Why the discoloration is mottled on the threads,
12. Why the 1988 carbon dating produced a 1260-1390 date for the Shroud,
13. Why the blood on the Shroud has a reddish color,
14. Why the blood that would have dried on the body is now on the cloth,
15. Why there is no image under the blood, and could possibly explain
16. Why the image of the face does not show distortion due to wrapping around the head.

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* - Papers by Robert A. Rucker can be downloaded from the research page of www.shroudresearch.net. Send comments and questions to robertarucker@yahoo.com.

Figures 1, 2, 6, 7, 8, 9, 10, and 11 are photos © Barrie M. Schwortz Collection, STERA, Inc.

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 of measurements. He has held Professional Engineering (PE) certificates in nuclear engineering and in mechanical engineering. This experience has been applied to the study of the Shroud of Turin since 2014. This includes running nuclear analysis computer calculations related to the carbon dating of the Shroud, organization of the International Conference on the Shroud of Turin (ICST-2017) held July 19-22, 2017, in Pasco, Washington, organizing the Shroud Research Network, and writing papers that are available on the RESEARCH page of the website www.shroudresearch.net.

Figure 1. Shroud as Seen (Top) and the Camera Negative (Bottom)

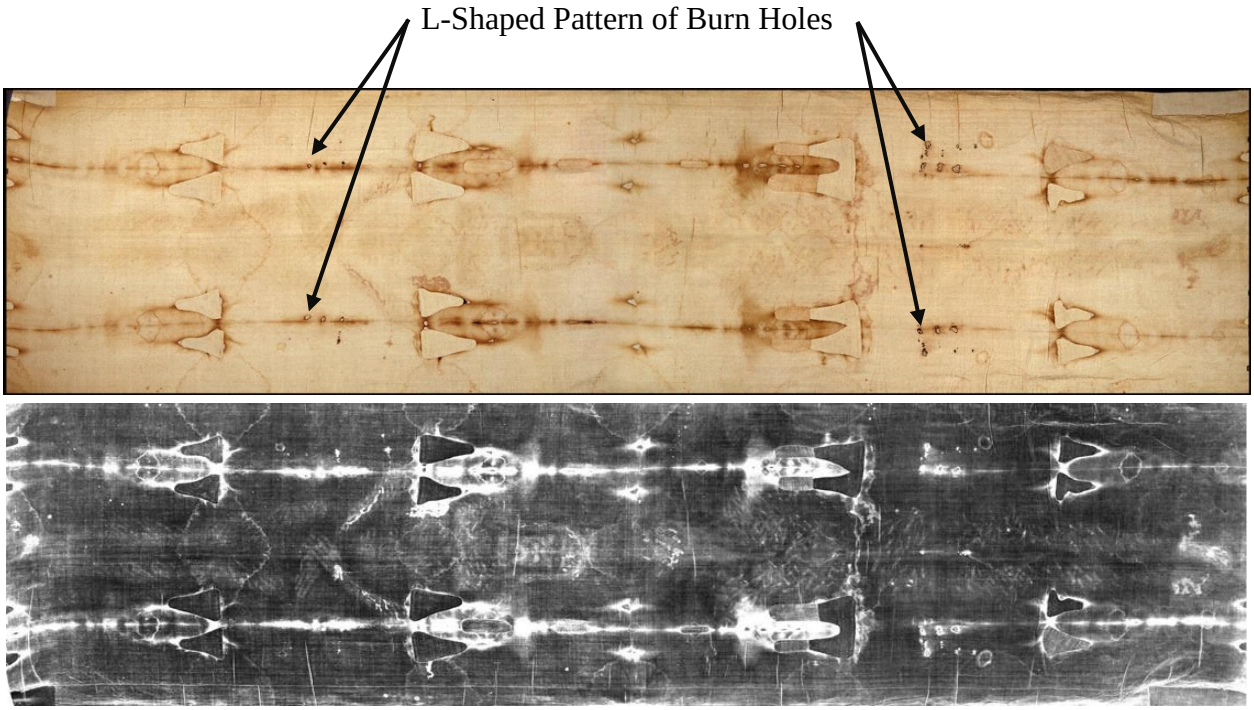

Figure 2. Closeup of the Weave and Discolored Fibers on the Shroud

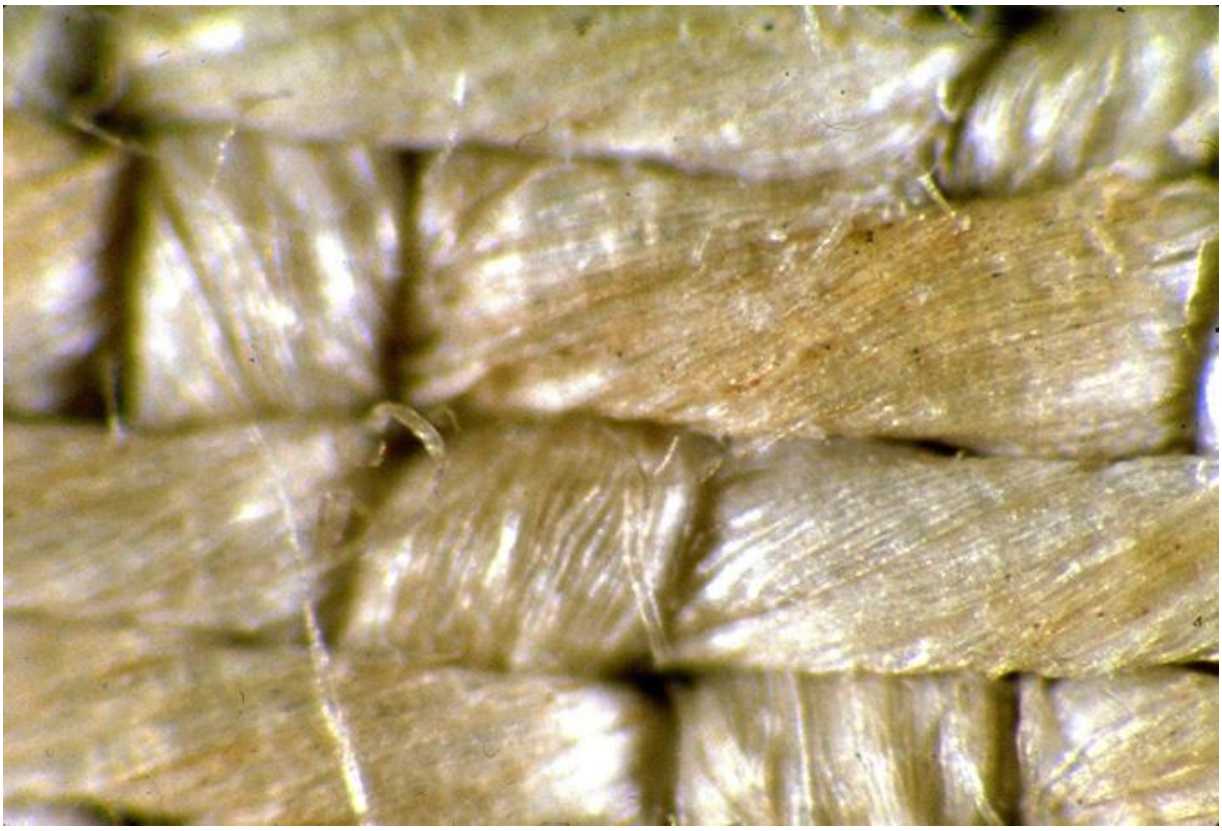

Figure 3.

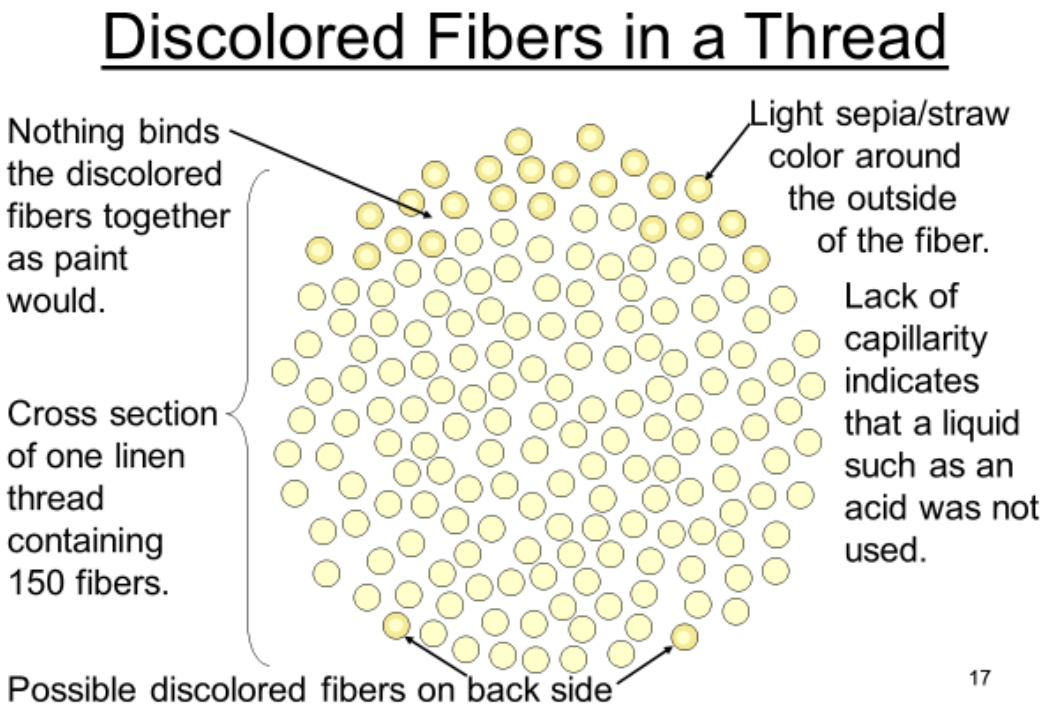

Figure 4.

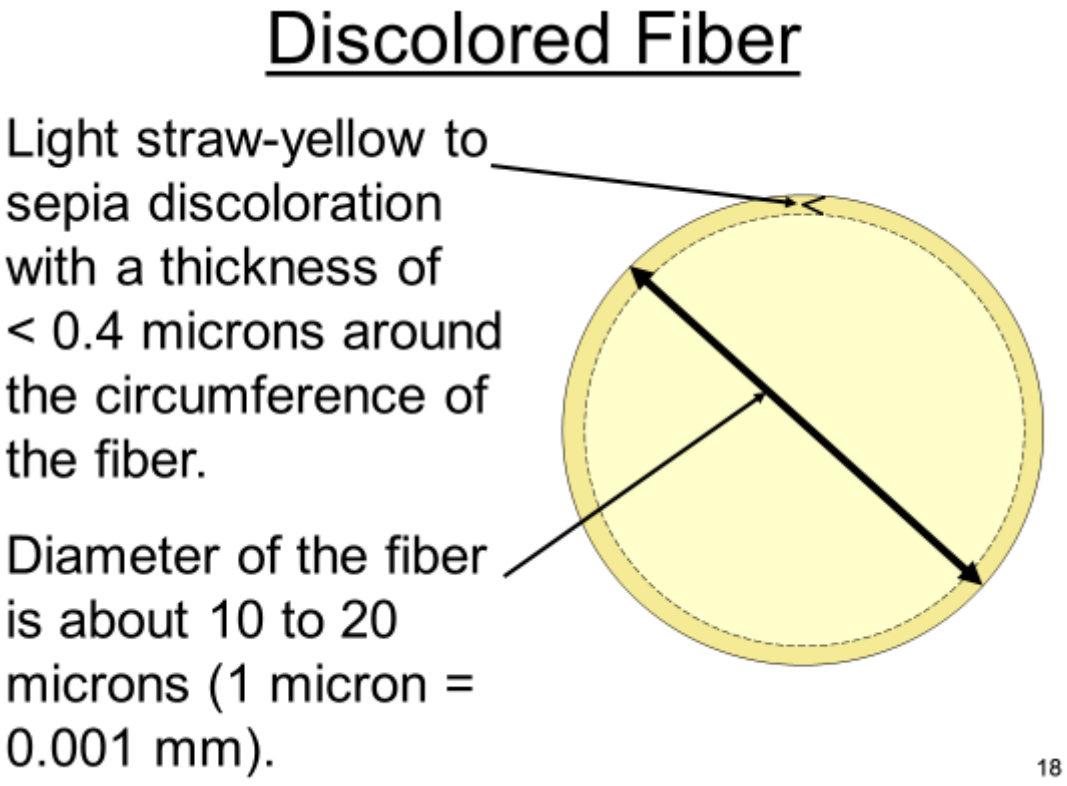

Figure 5. History of the Shroud

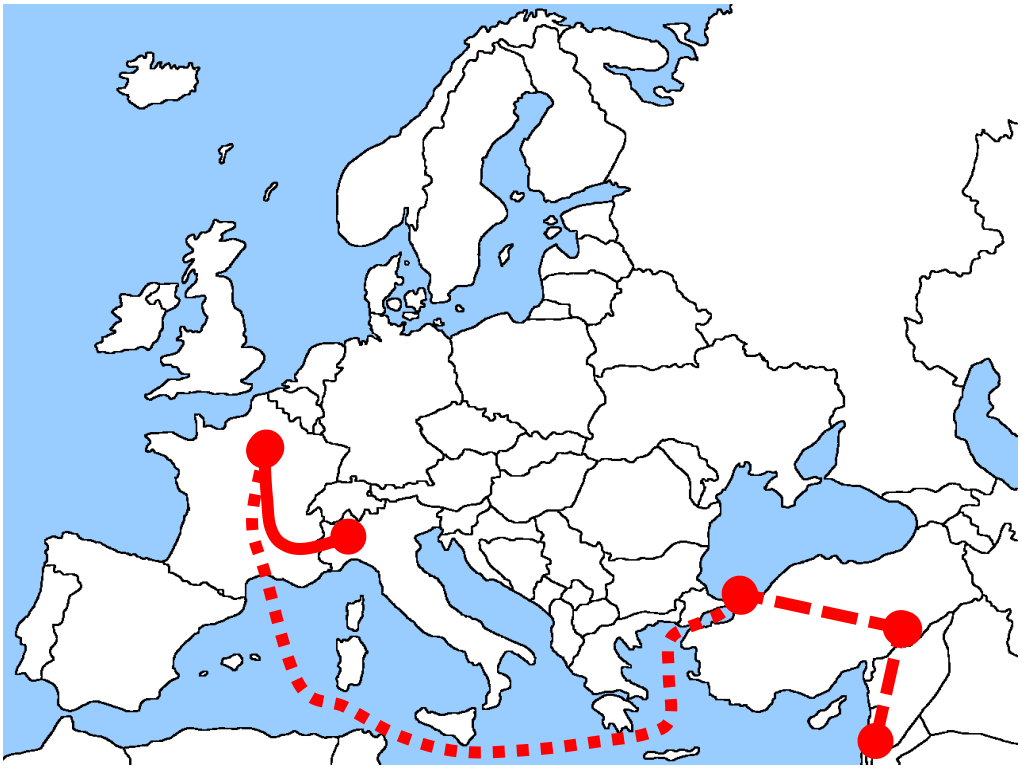

Figure 6. L-Shaped Pattern of Burn Holes in Each Quadrant

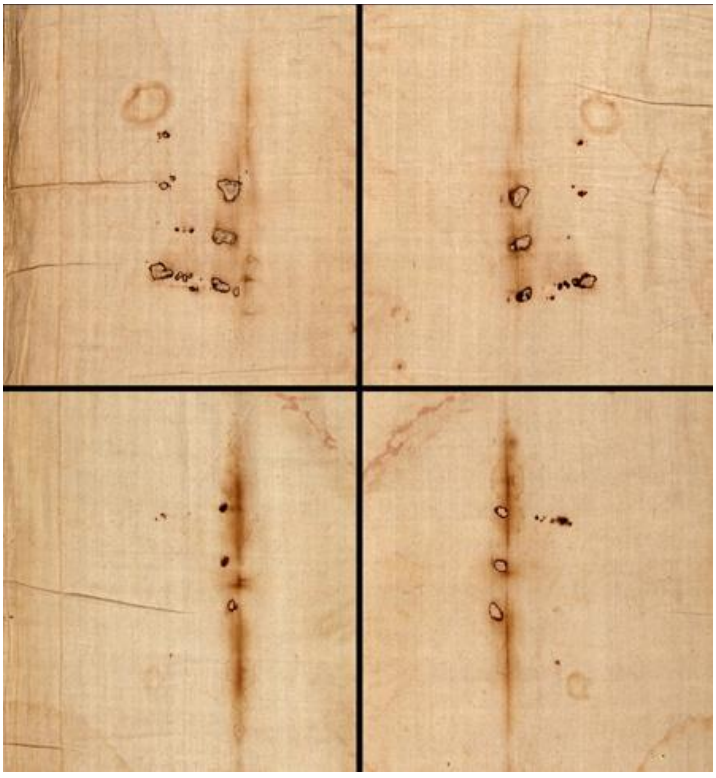

Figure 7. One Page from the Hungarian Pray Manuscript

Figure 8. Bottom of the Above Page

Figure 9. Close-up of the L-Shaped Hole Pattern

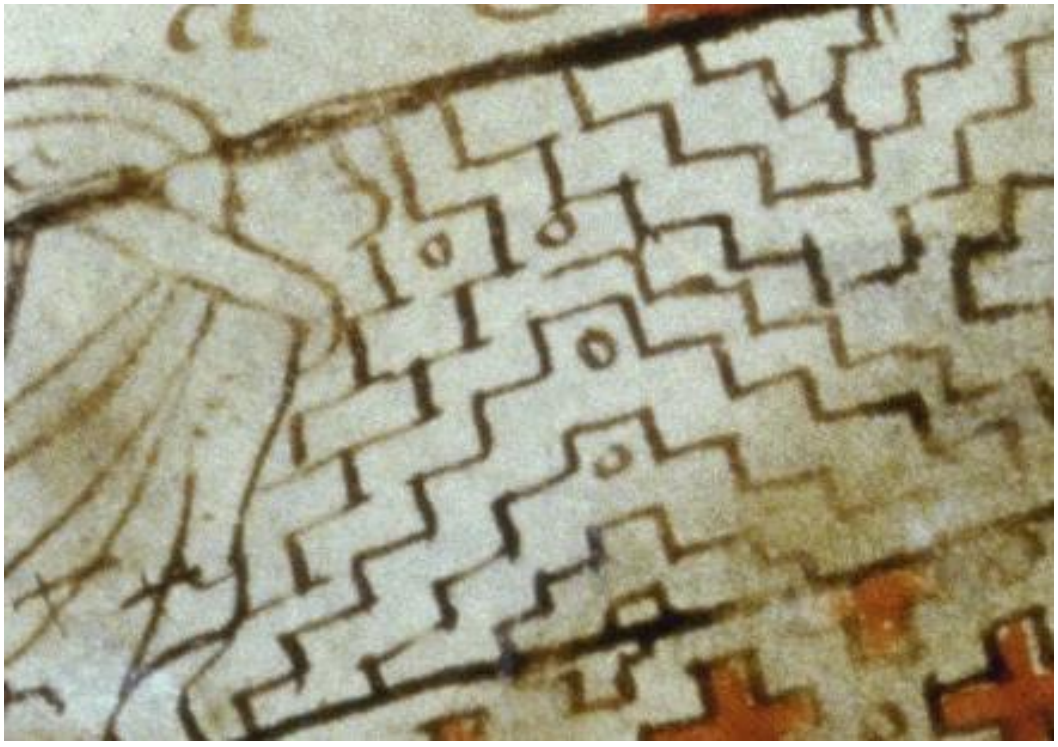

Figure 10. Cutting Samples from the Shroud for Carbon Dating in 1988

Figure 11.

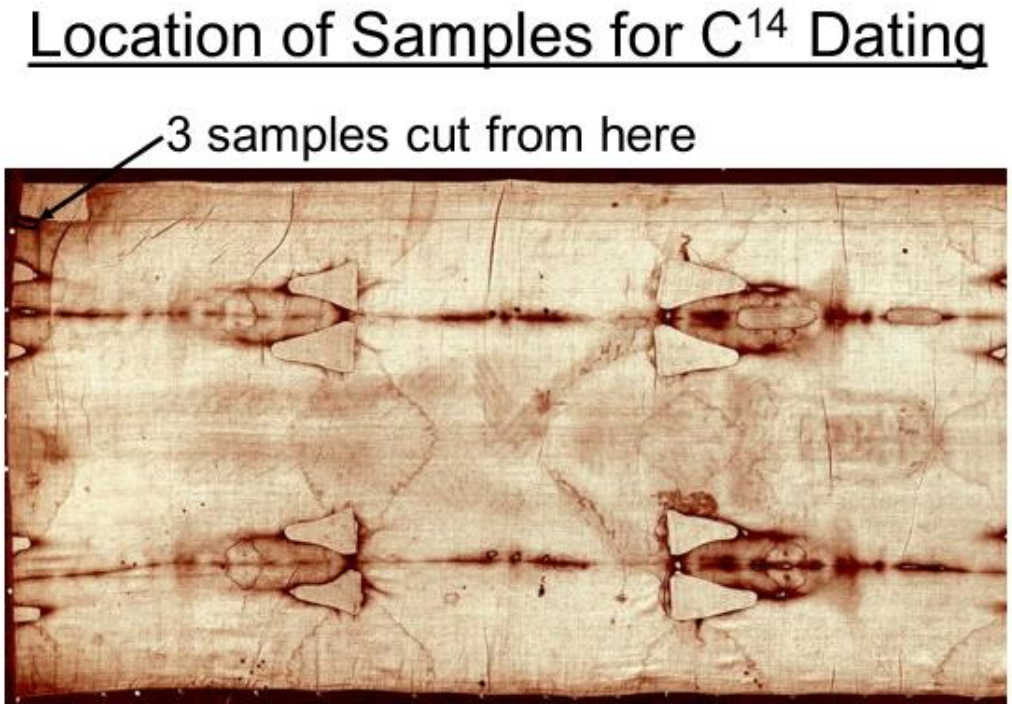

Figure 12.

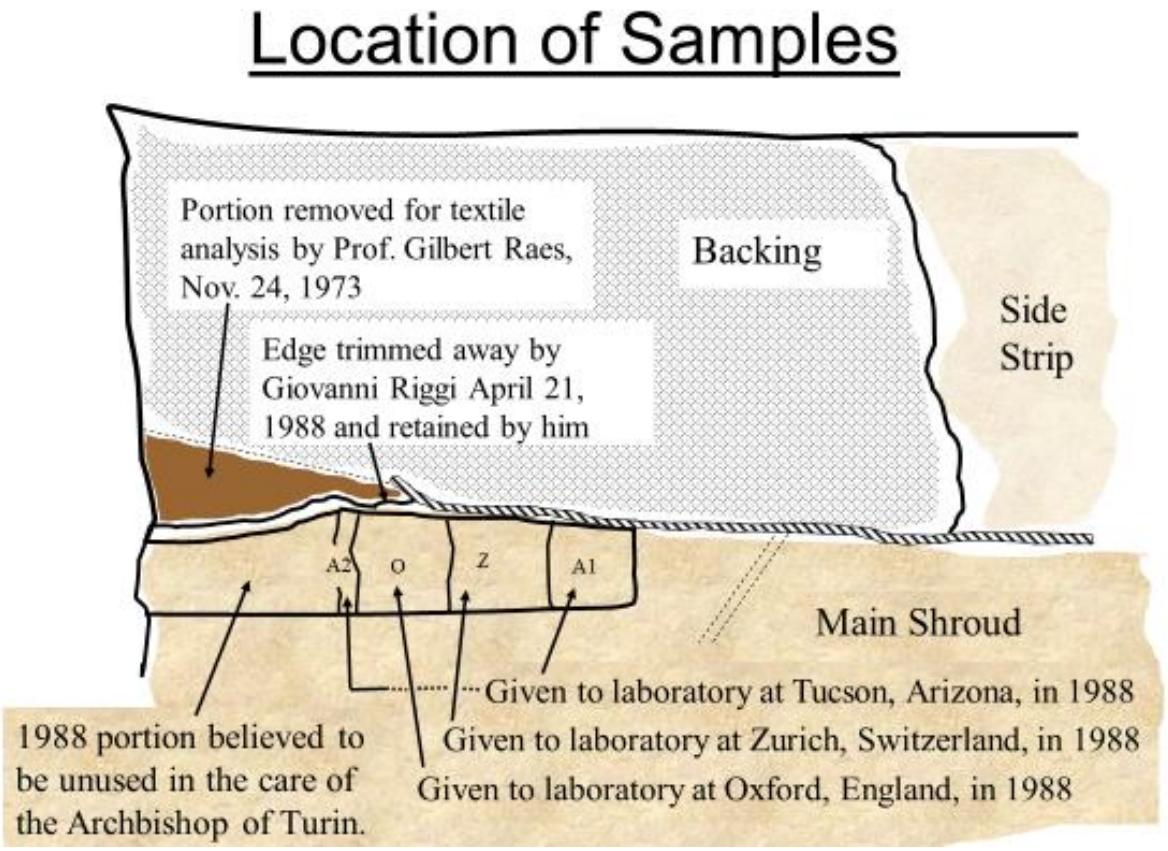

Figure 13. C^{14} Date in the Shroud Below the Body

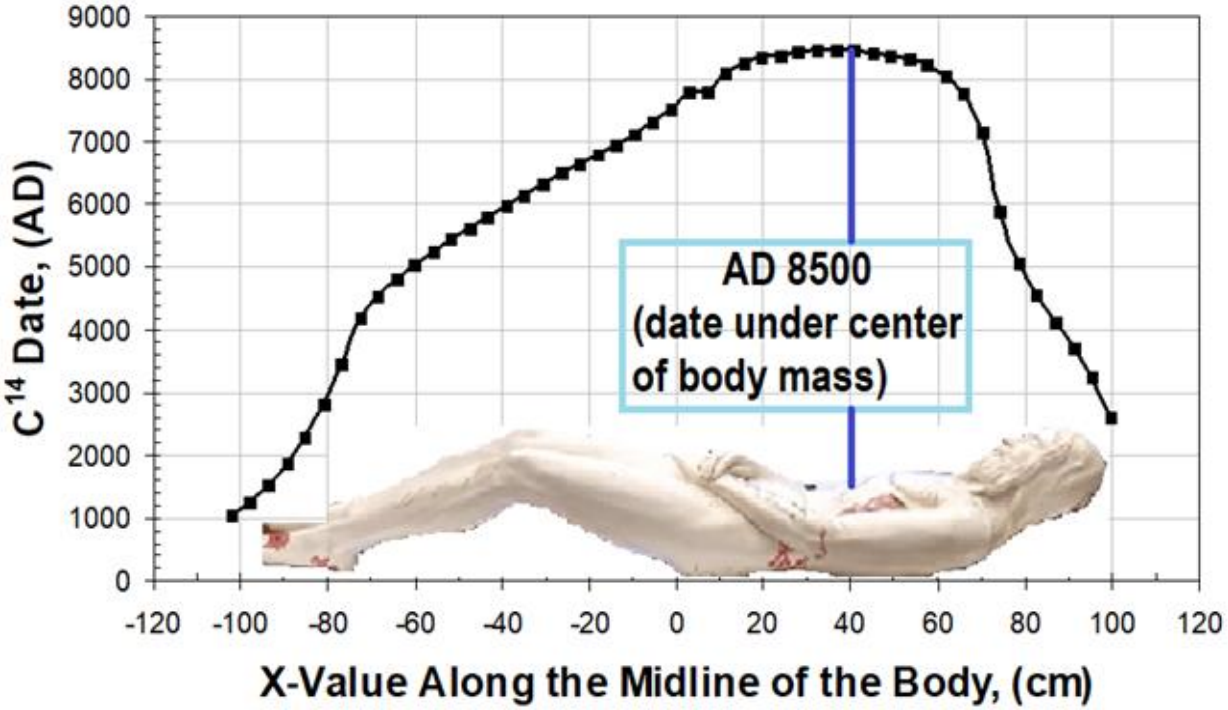

Figure 14. Dates are a Function of Sample Location

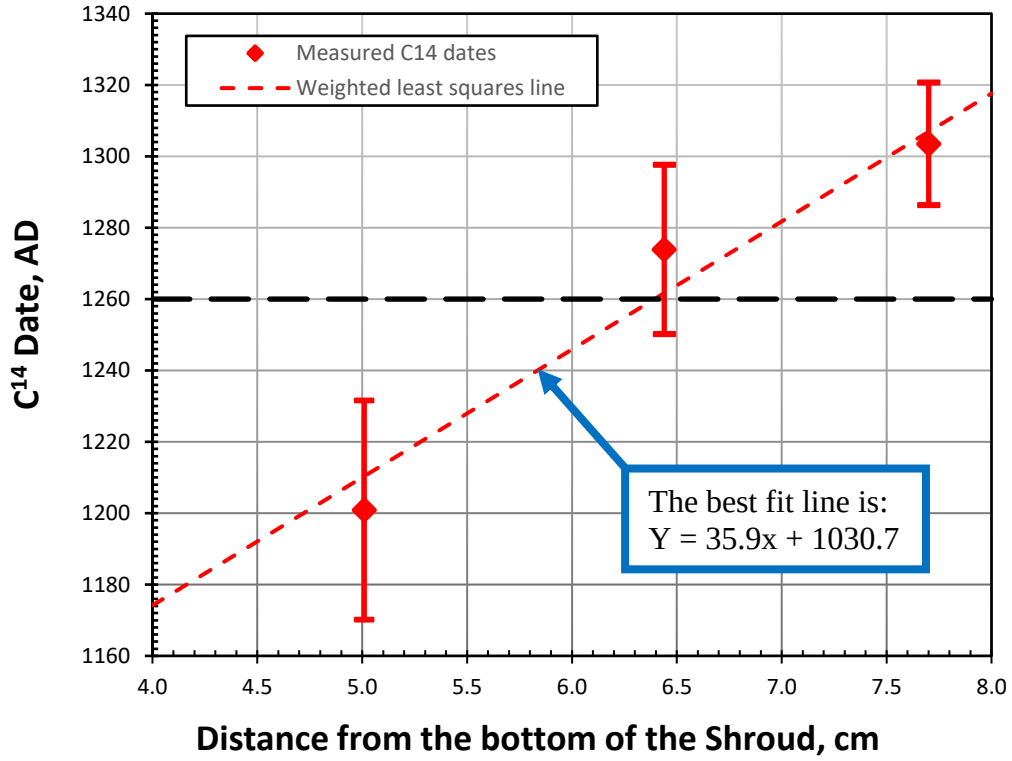

Figure 15. Effect of Producing New C^{14}

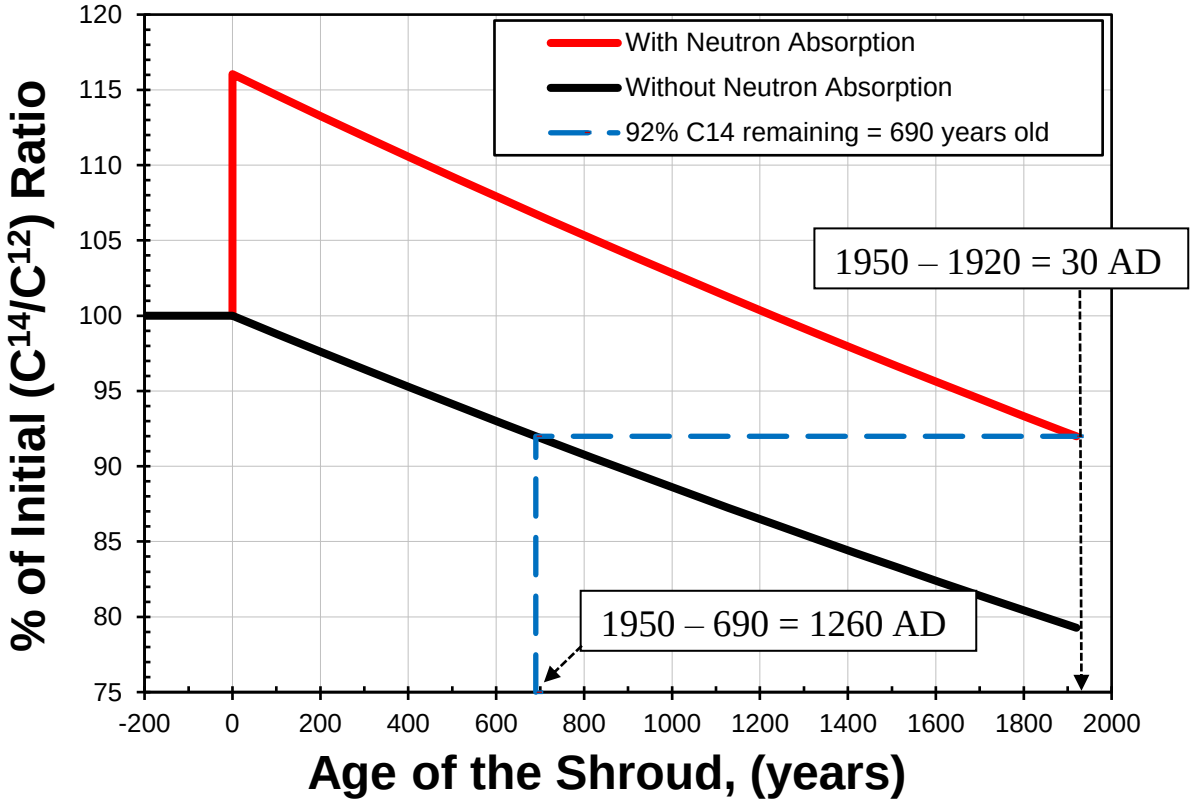

Figure 16.