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HYPOTHESIS TO EXPLAIN THE IMAGE FORMATION AND CARBON DATING ON THE SHROUD OF TURIN

HIPÓTESE PARA EXPLICAR A FORMAÇÃO DA IMAGEM E DATAÇÃO POR CARBONO NO SUDÁRIO DE TURIM

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ABSTRACT – The Shroud of Turin contains full-size front and dorsal (back) images of a man who was crucified exactly as Jesus was crucified according to the New Testament. The mysteries of the Shroud include how the images were formed and why the Shroud was carbon dated to 1260-1390 AD. By following the scientific evidence where it leads, the Vertically Collimated Radiation Burst (VCRB) hypothesis was developed to explain these mysteries. According to this hypothesis, an extremely brief vertically oriented oscillation of the nuclei in the body caused about 0.0004% of the deuterium nuclei to fission or split, causing protons and neutrons to be emitted oscillating between vertically up and vertically down directions. It was deuterium nuclei that split because this isotope requires the least energy to split. The protons deposited their electric charge on the cloth, with the oscillating

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vertical direction of the protons causing an alternating electrical current in the image fibers. This caused heating of a very thin region around the circumference of the fibers which discolored them by a scorch mechanism, producing the front and dorsal images of a crucified man. The neutrons emitted from the splitting deuterium would have produced new C-14 atoms by neutron absorption in N-14 in the linen thread. This new C-14 would shift the carbon date forward relative to the true date. Nuclear analysis computer calculations indicate that this new C-14 produced in the samples cut from the corner of the Shroud in 1988 can explain the 1988 carbon dating of the Shroud including: 1) a mean or average date of 1260-1390 AD, 2) a change in the carbon date as a function of the distance from the short edge of the cloth of about 36 years per cm, 3) the distribution of the carbon dates that were measured for the 12 subsamples, and 4) the average carbon date of about 700 AD for the Sudarium of Oviedo, which is believed to be Jesus' face cloth in John 20:7. An assumption of naturalism with the Shroud being made in 1260 results in a deviation from the measured carbon dates that was 4.5 times larger than if the Shroud was made in 33 AD with neutron emission from Jesus' body in his resurrection.

KEYWORDS – Shroud of Turin; Vertically Collimated Radiation Burst (VCRB); neutron emission; carbon dating; image formation.

RESUMO – O Sudário de Turim contém imagens frontais e dorsais (costas) em tamanho real de um homem crucificado exatamente como Jesus foi crucificado, segundo o Novo Testamento. Os mistérios do Sudário incluem como as imagens foram formadas e por que o Sudário foi datado por carbono entre 1260 e 1390 d.C. Seguindo as evidências científicas, a hipótese da Explosão de Radiação Colimada Verticalmente (VCRB) foi desenvolvida para explicar esses mistérios. De acordo com essa hipótese, uma oscilação extremamente breve, orientada verticalmente, dos núcleos no corpo causou a fissão ou divisão de cerca de 0,0004% dos núcleos de deutério, resultando na emissão de prótons e nêutrons que oscilavam entre direções verticais para cima e para baixo. Foram os núcleos de deutério que se dividiram porque esse isótopo requer a menor energia para se dividir. Os prótons depositaram sua carga elétrica no tecido, e a oscilação vertical dos prótons gerou uma corrente elétrica alternada nas fibras da imagem. Isso causou o aquecimento de uma região muito fina ao redor da circunferência

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das fibras, o que as descoloriu por um mecanismo de queimadura, produzindo as imagens frontal e dorsal de um homem crucificado. Os nêutrons emitidos pela fissão do deutério teriam produzido novos átomos de C-14 por absorção de nêutrons pelos núcleos de N-14 presentes no fio de linho. Esse novo C-14 corrigiria a datação por carbono para a data correta. Cálculos computacionais de análise nuclear indicam que o novo carbono-14, produzido nas amostras retiradas do canto do Sudário em 1988, pode explicar a datação por carbono do Sudário realizada em 1988, incluindo: 1) uma data média de 1260-1390 d.C.; 2) uma variação na datação por carbono em função da distância da borda menor do tecido de cerca de 36 anos por centímetro; 3) a distribuição das datações por carbono medidas para as 12 subamostras; e 4) a datação média por carbono de cerca de 700 d.C. para o Sudário de Oviedo, que se acredita ser o pano que cobria o rosto de Jesus em João 20:7. Considerando o naturalismo, com o Sudário sendo confeccionado em 1260 d.C., o desvio em relação às datações por carbono medidas é 4,5 vezes maior do que se o Sudário tivesse sido feito em 33 d.C., com emissão de nêutrons do corpo de Jesus em sua ressurreição.

PALAVRAS-CHAVE – Sudário de Turim; Explosão de radiação colimada verticalmente (VCRB); emissão de nêutrons; datação por carbono; formação de imagem.

Introduction

The Shroud of Turin is one of the most mysterious and potentially significant items in human possession. A shroud is a piece of cloth that a person is buried in. Turin or Torino is a city in north-western Italy. The Shroud of Turin (Figure 1) is a linen cloth that measures about 441 cm long by 112 cm wide (about 14 feet 6 inches by 3 feet 8 inches). The Shroud is made of linen thread made of fibers from the flax plant that was woven into a 3-to-1 herringbone twill weave with each linen thread containing about a hundred or more flax fibers twisted together. Each of these flax fibers is about one fifth the diameter of a human hair. The unique characteristic about the Shroud is that it contains full-size front and dorsal (back) images of a man who was crucified exactly as Jesus was crucified according to the New Testament. These images on the Shroud are caused by fibers in some of the threads being discolored with a straw-yellow or light sepia discoloration, which is the color of a scorch. Based on these images,

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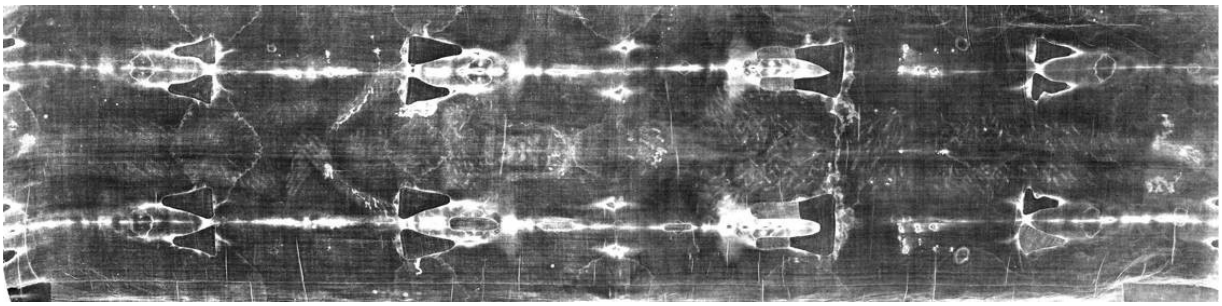
ancient tradition has long claimed the Shroud of Turin to be Jesus' burial cloth. This paper maintains that the scientific evidence substantiates this view.

FIGURE 1



Shroud of Turin, Camera Negative View

Jesus' dead body would have been brought into the tomb and laid on half of the long cloth used to wrap his body. The face or head cloth that was placed around his head after he died on the cross would then have been removed and laid aside in the tomb. The other half of the body cloth would then have been wrapped over his head and brought down over his feet. Cloth tie strips and cloths for washing the body may have also been in the tomb. Jesus' face or head cloth (Figure 2), mentioned in John 20:7, is believed to now be in Oviedo, Spain, based on documentation that arrived with it. It is a low-quality linen cloth about 84 by 54 cm (33 by 21 inches). It contains no image of the body, evidently because it was not on the body at the instant of Jesus' resurrection. However, it contains blood with a similar pattern to the blood on the Shroud.

According to ancient tradition the Shroud was placed into a hidden location above a gate in a wall around a city, perhaps about 200 AD, to protect it from the many persecutions in early Christianity. It was found many years later, perhaps about 500 AD, when the wall had to be rebuilt due to previous fires and floods. The Shroud then became well known and highly revered in the Byzantine Empire where it inspired paintings (Byzantine iconography) starting about 550-600 AD and images on coins starting in 692-695 AD. For example, a coin minted in 1025 to 1028 AD had Jesus' face from the Shroud on one side and the words "Jesus Christ, King of Kings" in capital Greek letters on the other side (Figure 3). This

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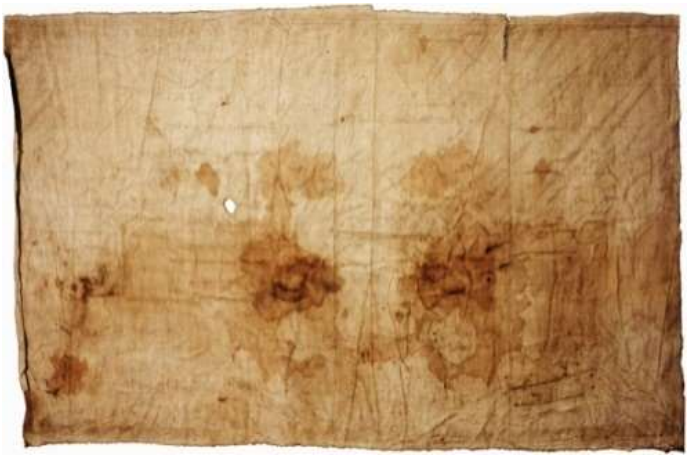
indicates that the Shroud was so well known and highly revered that the emperor of the Byzantine Empire took his image off the coin to put the image of Jesus' face from the Shroud and a statement of his identity onto the coin. The Shroud was also included in a colored line drawing in the Pray Codex (Figure 4), which is dated to 1192-1195. Robert de Clari, who was with the fourth crusade in Constantinople in 1203, reported that "the Shroud in which our Lord had been wrapped" was exhibited every Friday in a church in Constantinople. The Shroud was also exhibited as Jesus' burial cloth in Lirey, France about 1356, was in a church fire in 1532 in Chambery, France, and has been in Turin, Italy since 1578. It is now in the cathedral in Turin and is exhibited only a few times a century. It was owned by the Savoy family, a prominent political family in Italy, from 1453 to 1982 when it was willed to the pope.

FIGURE 2



Jesus' Face Cloth

In 1988, the corner of the Shroud was carbon dated to the range of 1290 to 1390 AD, but the above history and many other indicators discussed below contradict this date range. The current situation is summarized by Professor Christopher Ramsey, a member (as C. R. Bronk) of the original team that did the carbon dating, when he said (https://c14.arch.ox.ac.uk/shroud.html) "There is a lot of other evidence that suggests to many that the Shroud is older than the radiocarbon dates allow and so further research is certainly needed. It is important that we

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continue to test the accuracy of the original radiocarbon tests as we are already doing. It is equally important that experts assess and reinterpret some of the other evidence. Only by doing this will people be able to arrive at a coherent history of the Shroud which takes into account and explains all of the available scientific and historical information."

FIGURE 3

Coin Minted in 1025 to 1028

Though experimental data is sparse due to the restricted availability of the Shroud, it is often said that the Shroud of Turin is the most researched ancient artifact in existence as indicated by the number of papers that have been written on the Shroud. Many of these are available on www.shroud.com. Research on the Shroud began in 1898 when Secondo Pia took the first photographs of the Shroud. Research on the Shroud can be divided into four periods. These four periods and their conclusions are summarized below.

1. 1898 to 1972: The images were formed by the body of a crucified man that was wrapped in the Shroud. This is indicated primarily by the nature of the blood on the Shroud.

2. 1973 to 1987: 3D information was discovered to be encoded into the 2D images on the Shroud in the early 1970s. This led to formation of the Shroud of Turin Research Project (STURP) which was invited to send about 26 researchers to Turin in 1978 to perform non-destructive experimentation on the Shroud over a five-day period, 24 hours a day. They concluded that the front and dorsal images on the Shroud were not formed by pigment, scorch, liquid,

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photography, or contact between the body and the cloth.

FIGURE 4

Image of the Shroud in the Pray Codex

3. 1988 to 2016: In 1988, samples were cut from the corner the Shroud and carbon dated to a range of 1260-1390 AD (Ref. 1), with a claimed 95% probability that the true date is within this range. They concluded that "The results provide conclusive evidence that the linen of the Shroud of Turin is mediaeval." This supposedly proved the Shroud could not be the authentic burial cloth of Jesus, which significantly decreased the interest in and research on the Shroud of Turin.

4. 2017 to 2022: After a freedom-of-information legal request, details of the 1988 carbon dating measurements were finally released by the British Museum in 2017. After this release of data, statistical analysis in four papers (Ref. 2, 3, 4, and 5) published in peer-reviewed journals concluded that the samples were heterogeneous. This means that the samples that were carbon dated were essentially different from each other because their carbon dates did not agree sufficiently with each other within their uncertainties. This means that that the samples could not be proven to be representative of the rest of the Shroud, so that the 1260-1390 AD date should be rejected, i.e., given no credibility.

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This paper discusses a hypothesis for explaining the image formation and carbon dating on the Shroud. It is important to understand that a "hypothesis" refers a concept that could be true, but is not a claim that it is true. Thus, more than one hypothesis at the same time could be considered to possibly explain the mysteries of the Shroud. A good hypothesis must be consistent with all the evidence that is known to be true, it should make predictions that are testable and falsifiable, and it is preferred if it explains more than one mystery, is simple with a minimum of assumptions, is confirmed by independent studies, etc. In the scientific methodology, a hypothesis can be proven to be false, at least as stated, if one of its predictions when tested is proven to be false. But if a hypothesis' prediction is proven to be true when tested, the hypothesis is not proven to be true, but only that the hypothesis gains in credibility. Thus, many predictions may have to be tested and proven to be true before a general consensus might develop that the hypothesis is probably true. Thus, in the scientific methodology, whether a hypothesis is true or false is determined by testing of its predictions.

The 1978 Testing of the Shroud

Development of a hypothesis for image formation begins with understanding the testing of the Shroud in 1978. The only comprehensive testing of the Shroud was performed by the Shroud of Turin Research Project (STURP) over a five day period (120 hours) in 1978. This involved about 26 researchers from the United States who were invited to go to Turin, Italy to perform non-destructive testing on the Shroud. Their main goal was to determine how the images were formed. They concluded (Ref. 6) the images could not be the product of paint, dye, or stain because there was:

1. No pigment in the fibers sufficient to form the images.
2. No evidence of a binder to hold pigment.
3. No clumping of fibers or threads.
4. No stiffening of the cloth.
5. No cracking of the images along fold lines.
6. No brush strokes
7. No outline

STURP also found no capillarity (soaking up of liquid) in the fibers or threads, so the images could not be due to a liquid such as an acid or an organic or inorganic chemical in a liquid form. A scorch caused by a hot object will fluoresce (emit light in the visible range) when exposed to ultraviolet light, which the human eye cannot see. When the Shroud was

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exposed to ultraviolet light, the scorches caused by the fire in 1532 fluoresced but the images did not fluoresce noticeably, though possibly very slightly. (As discussed below, this very slight fluorescence was evidently due to the discoloration around the circumference of the fibers being only about 0.2 to 0.6 micrometers thick on only the top two or three fiber layers in a thread, with the inside of the fibers not discolored.) This indicated the images were not made by contact of a hot object with the cloth. The images on the Shroud were not the result of a photographic process because no light sensitive chemicals were detected on the cloth and because the images contain 3D or topographical information related to the vertical distance from the body to the cloth (Ref. 7, 8, 9). Normal photographs and paintings do not contain 3D information. The images were also not due to contact between the body and the cloth because there are discolored fibers in the images where there would not have been contact between the body and the cloth, such as images of the nostrils on either side of the tip of the nose.

STURP also concluded (Ref. 10 and 11) that only the top two or three layers of fibers were discolored out of about 100 flax fibers in a thread. This discoloration does not extend across the entire diameter of the fibers, which is about 15 micrometers (μm) in diameter, about one-fifth the diameter of a human hair. An image fiber is only discolored in a very thin region that extends around the circumference of the fiber. The thickness of this discoloration is only about 0.2 μm to 0.6 μm (micrometer). This thin discolored layer extends around the entire circumference of a fiber over much of the length of the discolored length of the image fiber.

STURP also concluded (Ref. 6) this discoloration is not due to any substance or material (atoms) added to the fibers, but rather is the result of a rearrangement of the atoms that were already in the fibers. The discoloration can be described as the result of a dehydration-oxidation chemical process. Specifically, the discoloration is due to some of the single electron bonds of the carbon atoms in the cellulose and other materials being changed to double electron bonds. This causes the molecule to vibrate differently so it reflects light differently, so it appears discolored. Thus, an image formation hypothesis must explain what could cause a dehydration-oxidation process to change single electron bonds in the fibers into double electron bonds. As discussed below, this is believed to have been caused by electrically deposited heat that scorched the thin

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circumferential region of the image fibers.

Image Formation on the Shroud

Every image that we see is the result of information. If we look at the scene around us, or look at a photograph, magazine, cell phone, television, or computer monitor, every image that we see is because of information that is, in some way, contained in the item that we are looking at. If we look at a person, the information that defines his appearance is inherent to his body and his clothing. In a photograph or magazine, the information is contained in the pattern of pixels in the photograph or magazine. In a cell phone, television, or computer monitor, the information is again in the pattern of the pixels in the screen. The same is true for the Shroud of Turin. The information that makes it possible for us to see the front and dorsal images of a crucified man on the Shroud is encoded into the pattern of the discolored fibers in the linen threads that make the Shroud. This helps us to realize the importance of considering information in understanding how the images were formed on the Shroud, though information is seldom considered in image formation hypotheses.

Three items are required to form the front and dorsal images of a crucified man on the Shroud of Turin:

1. A mechanism to discolor the fibers, since it is the discoloration of the fibers that form the front and dorsal images of a crucified man on the Shroud.
2. Energy to drive the discoloration mechanism.
3. Information to control the discoloration mechanism.

This information must control which fibers are to be discolored and the length of that discoloration on the fibers. This information must be that which defines the appearance of the front and back of a man that was crucified exactly like Jesus was crucified according to the Gospels in the New Testament. The information that defines the appearance of a crucified man was not in the air or limestone in his tomb. It was only inherent to the dead body of the crucified man that was in the tomb. This means that the information that defined the appearance of a crucified man had to start at the body. Then this information had to be transported from the body to the cloth and then be deposited onto the cloth. This information was deposited onto the cloth in the pattern of discolored fibers on the cloth. Thus, we can see the images of a crucified man on the Shroud because the information that

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defines his appearance has been encoded into the pattern of the discolored fibers on the Shroud.

In general, photons of light that reflect off an object carry the information regarding the appearance of the object in their frequency, intensity (number of photons), and angle they enter the lens of our eyes. The photon's frequency, intensity, and angle carry information related to the color, shade (light vs dark), and position of every point in the images. These photons are focused by the lens in our eyes onto the rods and cones at the back of our eyes, and in doing so, the information they carry is also focused there. These rods and cones at the back of our eyes translate the information in the photons into electrical signals which travel up our optic nerves to our brains which have learned to interpret these electric signals as the object that is being viewed. The same is true for the Shroud of Turin except that the front and back images on the Shroud do not show the color of the man. This is because of the way in which the images were made by a scorching of the fibers rather than by pigment.

Proposals that the images were made by artists or forgers, when tested, are always inconsistent with some aspects of the macroscopic (large scale) and microscopic (small scale) evidence on the Shroud, so they cannot be true. The evidence on the Shroud related to the images indicates that the images were not made by a human agent, since the STURP analysis concluded that the images were not made by pigment, scorch, any liquid, or photography, and since many characteristics of the images could not have been formed by a human agent such as 3D information on the Shroud and the image fibers only being discolored in a very thin region less than a micrometer thick around the entire circumference of the fibers. The images could not be due to contact between the body and the cloth because the images were formed where the cloth would not have been in contact with the body, such as down the nostrils off the tip of the nose. And the images could not have been formed by random motion of molecules as in diffusion of a gas, since the random path of the molecules would only cause a blur on the cloth due to loss of the information required to form an image of a crucified man. It should be realized that the images on the Shroud can only be seen because the information that defines the image of a crucified man has been encoded in a focused manner into the pattern of the discolored fibers on the cloth.

Also, if the images on the Shroud were formed by a naturalistic or normal process, then we should expect there to be many examples of burial

shrouds containing images of the bodies they wrapped. Instead, there is only one burial cloth with an image of the person it covered, and the images on this cloth show a man that was crucified exactly like Jesus was crucified according to the New Testament. The uniqueness of the images on this cloth indicates that the images were probably made by a process so unique it may never have been investigated by science, and so may be outside or beyond our current understanding of physics.

Though many hypotheses have been proposed to explain the images on the Shroud, most Shroud researchers have rejected the above options in favor of the images being formed by radiation emitted from the body. Some type of radiation hypothesis is necessary to explain all of the following evidence:

1. The STURP results indicate that the images were not made by pigment, scorch, liquid, or photography.
2. The images have a good resolution.
3. Images were formed even where the cloth would not have been in contact with the body.
4. There is a smooth gradation of the discoloration in the images.
5. There are no images of the sides of the body or the top of the head.
6. Geometrically, the front image is a vertical projection upward from the body and the dorsal image is a vertical projection downward from the body.
7. The front and dorsal images on the Shroud are similar to negative images with light and dark areas reversed.
8. There is 3D or topographical information encoded into the 2D images with the intensity of the discoloration inversely related to the distance between the body and the cloth.
9. The front and dorsal images have similar characteristics as though both images were made by the same process, independent of the weight forcing the body and the cloth together.

The best known radiation hypotheses to explain the image formation are the following:

1. The cloth collapse hypothesis promoted by John Jackson (Ref. 12 and 13) and Mark Antonacci (Ref. 14 and 15). This hypothesis proposes that when Jesus' body disappeared from within his burial cloth, gravity and air pressure difference would have caused the cloth to collapse into the volume previously occupied by the body where the cloth encountered radiation that caused the images by radiation damage.
2. The Holy fire / corona discharge hypothesis promoted by Giulio Fanti (Ref. 16 and 17). This hypothesis

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proposes that energy was provided by a very short burst of "Holy fire" that caused a corona discharge that discolored the fibers.

3. The ultraviolet hypothesis promoted by Paolo Di Lazzaro (Ref. 18 to 22). This hypothesis proposes that an extremely intense and extremely short duration burst of ultraviolet (UV) light was emitted from Jesus' body during his resurrection. This UV light discolored the fibers by radiation damage.

4. The Vertically Collimated Radiation Burst (VCRB) hypothesis promoted by Robert A. Rucker (Ref. 23 to 25). This hypothesis proposes that a very intense high frequency vertical oscillation of the nuclei in Jesus' body caused a small fraction of the deuterium nuclei in his body to split, releasing protons and neutrons. This burst of radiation is best understood to have occurred at Jesus' resurrection. The protons caused the images by electrical heating that scorched the fibers, and the neutrons produced new C-14 on the Shroud that shifted the carbon date for the samples to the future relative to the true date.

Of these four radiation hypotheses, the hypothesis discussed in this paper is #4, the Vertically Collimated Radiation Burst (VCRB) hypothesis. This is because the author believes the following are probably true about the VCRB hypothesis:

1. It is the only hypothesis that was developed from the "bottom up" by starting with a consideration of all the evidence related to the images, rather than being developed from the "top down" by starting with a concept that might have discolored the fibers.

2. It is the only hypothesis that uses a concept, the "skin effect" of an alternating current (https://en.wikipedia.org/wiki/Skin_effect), that is capable of discoloring only a very thin region around the circumference of a flax fiber, which is about one-fifth the diameter of a human hair, without discoloring the inside of the fiber. The main problem with radiation damage explaining the images is that for radiation damage to explain the discoloration on the back of an image fiber, the radiation must go through the fiber which would discolor the inside of the fiber, contrary to the evidence on the Shroud.

3. It may be the only hypothesis that makes predictions that are testable, falsifiable, and some of which are unique. Testing of predictions is how a hypothesis can gain enough credibility to be accepted as probably true.

4. It is the only hypothesis that explains more than one significant mystery of the Shroud by explaining both the image formation and the carbon dating.

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5. It is the only hypothesis that explains all four types of data related to the carbon dating of samples from the Shroud: 1) the mean or average date, 2) the variation with location, 3) the distribution of the carbon dates for the 12 sub-samples from the Shroud, and 4) the mean carbon date of the Sudarium of Oviedo, which is believed to be Jesus' face cloth mentioned in John 20:7.

As stated above, for an image formation hypothesis to be true, it must be consistent with all the evidence related to the images. As a result, the most reliable way to develop a hypothesis for how the images were formed is to consider all of the evidence related to the images. To do this, 27 evidences related to the images were identified and considered one at a time (pages 5 to 16 of Ref. 23). This process allowed the hypothesis to be gradually developed with each new conclusion being added to the conclusions from all the previous evidences. The 27 evidences used to develop the VCRB hypothesis (Ref. 23) are listed below.

1. According to experiments performed in 1978 over a five day period (120 hours) by about 26 researchers associated with the Shroud of Turin Research Project (STURP), these images have no pigment, no binder to carry the pigment, no clumping of fibers or threads, no stiffening of the cloth, no cracking along fold lines, no brush strokes, and no outline.

2. STURP concluded the images were also not caused by a scorch from a hot object, any liquid, or by a photographic process.

3. There is a smooth gradation of discoloration on the Shroud from points vertically closer to the body relative to points vertically further from the body.

4. STURP also detected no body decay products on the cloth.

5. The images are formed by some of the flax fibers in the linen threads being discolored.

6. The Shroud contains full size front and dorsal (back) images of a man who was scourged and crucified exactly like Jesus was scourged and crucified according to the New Testament.

7. The image of the face is a normal width for a human face.

8. The front image is a vertical projection upward from the body. The back image is a vertical projection downward from the body.

9. The Shroud does not include images of the sides of the body or the top of the head.

10. The front and dorsal images have a good resolution, perhaps in the few mm range.

11. Based on the location of the blood on the Shroud, the front and

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dorsal images are on the side of the cloth that faced the body. There appears to be very dim indications of the face and the hands on the other side of the cloth, i.e., on the outside of the wrapped configuration, though this is disputed.

12. A typical linen thread contains a hundred or more flax fibers twisted together. The images on the Shroud are caused by fiber discoloration in only the top two or three layers of fibers in a thread, with those discolored fibers facing toward the body, on both the front as well as the dorsal image.

13. The threads in the images are discolored in a mottled pattern, yet this mottled pattern forms the front and dorsal images of a crucified man.

14. The density of ion tracks in the image fibers is about the same as the density of ion tracks in the non-image fibers.

15. The discoloration on all the discolored fibers has approximately the same color, usually called a straw-yellow or light sepia color.

16. A flax fiber has a diameter of about 15 microns or micrometers (μm = one millionth of a meter), which is about one-fifth the diameter of a human hair. The discoloration on an image fiber has a thickness of less than 0.2 μm, with the discoloration around the outer circumference of the fiber, with the inside of the flax fiber not discolored. Thus, in this example of a flax fiber with a 15 μm diameter, the inside 14.6 μm of the fiber diameter would not be discolored. [Note: the discoloration is probably in the range of 0.2 to 0.6 μm]

17. There appears to be images of bones on the Shroud. This includes bones near the surface of the body such as teeth, bones in the hands, and perhaps in the backbone.

18. The images are two-dimensional yet contain 3D or topographical information related to the vertical distance from the body to the cloth at each point.

19. The images are negative images, i.e. with dark and light areas reversed.

20. The front and dorsal images have about the same quality, as though they were both made by the same process.

21. The discoloration on the image fibers is due to some of the single electron bonds of the carbon atoms being changed to double electron bonds.

22. The Shroud of Turin Research Project (STURP) concluded that the discoloration on the fibers is not caused by any material being added to the fibers.

23. The top threads facing the body create a non-discolored region on otherwise discolored threads that are

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beneath them, like a "shadow" of the top thread on the under thread.

24. There are multiple "hot spots" on the mustache that are more discolored than the rest of the mustache.

25. The images were not affected by heat in the 1532 fire or by subsequent water thrown onto the Shroud after the fire.

26. Images of various parts of flowers were encoded on the side of the Shroud facing the body, as though flowers were placed between the section of the cloth that was below the body and the section of the cloth above the body.

27. During the STURP experiments in 1978, many oxidizing and reducing agents were applied to image fibers to determine which agents would eliminate the fiber discoloration. None of them eliminated the discoloration except for diimide which eliminated the discoloration immediately when it was applied.

At each step in considering these 27 evidences, the question was asked "What would cause this?" This caused a focus on following the evidence where it led, which established a 12-step sequence of cause-and-effect relationships to be recognized. This consideration started at the first or bottom level with the existence of the images on the cloth, and ended with the top level or root cause that logically resulted in the images on the Shroud. This 12-step sequence of cause-and-effect relationships, from the root cause down to the presence of the images on the Shroud, is given below:

Top level or root cause: Rapid vertical oscillation of nuclei in the body.

→ This caused some (0.0004%) of the deuterium nuclei in the body to split.

→ This caused protons and neutrons to be emitted vertically in the body, oscillating between up and down directions.

→ This resulted in some of the protons exiting from the body, oscillating between up and down directions.

→ This caused protons to deposit their positive charge on the cloth, oscillating between the top cloth and the bottom cloth.

→ This caused a corona or static discharge between the body and the cloth, oscillating between the top cloth and the bottom cloth.

→ This caused an alternating electrical current in the top fibers of the threads facing the body.

→ This caused oscillating electrical & magnetic fields in and around the top fibers in the cloth.

→ This caused electrons to flow primarily in outer radius around the circumference of the image fibers.

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→ This caused heat to be deposited in the thin outer radial region of the fibers facing the body.

→ This heat scorched the thin outer radial region of the fibers.

→ This discolored the top fibers in the images to the color of a scorch, which is a light sepia or straw-yellow color.

→ This caused the front and dorsal images of a crucified man on the Shroud.

The above 12-step cause-and-effect sequence led to the root cause of the images being the vertical oscillation of the nuclei in the body. This root cause was not expected, but was logically deduced. This vertical oscillation of the nuclei in his body is outside of our current understanding of the laws of physics, so that it is not possible to know what could have caused it within our current understanding of the laws of physics.

A human body is made of organs and tissues that are made of proteins that are made of molecules that are made of atoms. Each of these atoms contains electrons circling a central nucleus where most of the mass is located. In the nucleus at the center of an atom are neutrons and protons, except for the most common form of hydrogen (H-1) which only contains one proton and no neutrons in the nucleus. However, about 0.015% of hydrogen atoms not only contain a proton in the nucleus but also a neutron. This form of hydrogen (H-2) is called deuterium or heavy hydrogen because this atom is twice as heavy as H-1.

As shown above, the top level or root cause of images on the Shroud was deduced from the evidence to be a rapid vertical oscillation of nuclei in the body. A "vertical oscillation" means that the nuclei (plural of nucleus) at the center of the atoms in the body were vibrating vertically up and down. It is hypothesized that this vertical oscillation was sufficiently strong, and at such a high frequency, that some of the nuclei split or fissioned into their component parts, i.e. protons and neutrons.

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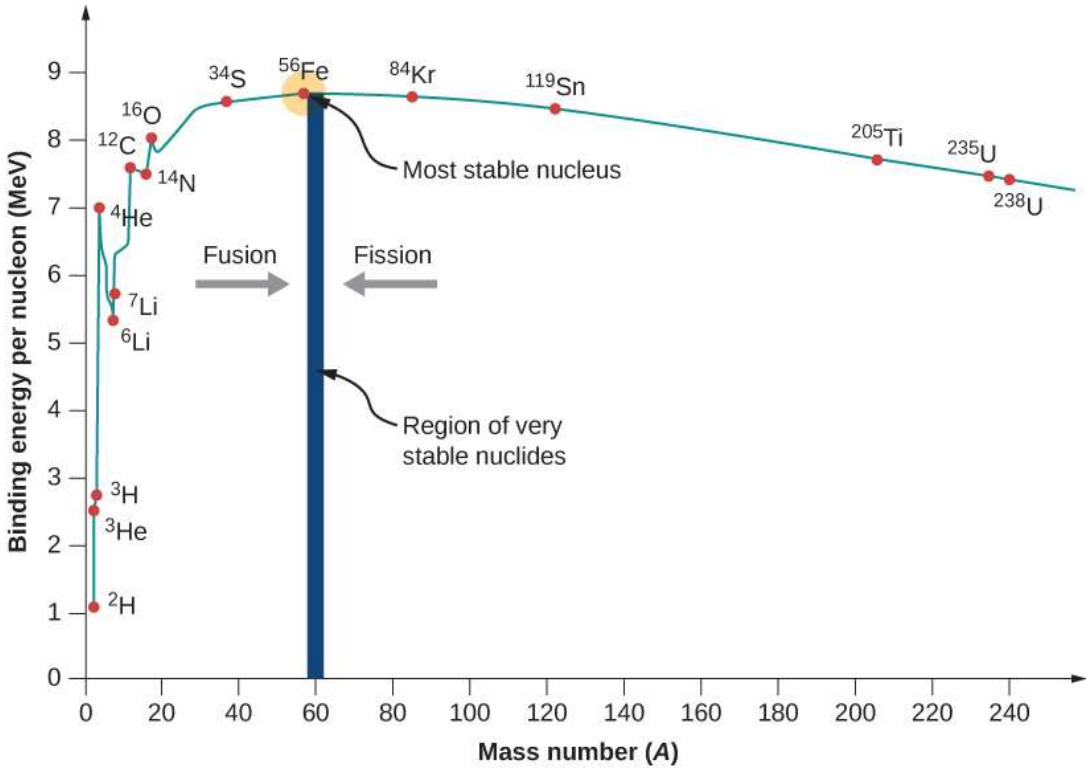
FIGURE 5



Binding Energy per Nucleon

The deuterium (H-2) nuclei would have been preferentially split because they require the least energy to split. This is shown on the far left side of Figure 5, which is the curve of binding energy per nucleon. A "nucleon" is either a proton or a neutron in the nucleus of the atom, so the number of nucleons in an atom is the sum of the number of protons and neutrons in the nucleus. These protons and neutrons in the nucleus of an atom are held together by an energy loss called the binding energy. To split the protons and neutrons in the nucleons from each other requires this same amount of energy be put into the nucleus as the binding energy. The curve in Figure 5 indicates that to split the proton from the neutron in the nucleus of a deuterium atom requires only slightly above one Mev (million electron volts), whereas isotopes of all other elements are far higher. This means that the deuterium nucleus will require the lest energy to split compared to other atoms, so it will be far more likely to split due to the

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energy provided by the hypothesized vertical oscillation of the nuclei in the body.

When a deuterium nucleus splits, it will emit the proton and neutron in opposite directions due to the law of conservation of momentum. To split a deuterium nucleus requires energy be put into the nucleus. This means it is an endothermic reaction rather than an exothermic reaction. Thus, the vertical oscillation of nuclei in the body (the root cause) will cause some of the deuterium nuclei in the body to split, releasing the same number of protons and neutrons. In the VCRB hypothesis, the protons form the images on the Shroud and the neutrons produce new C-14 on the Shroud that shifts the carbon date forward from the true date. The fraction of the deuterium nuclei that split was determined to be 0.0004%. This value was determined by the number of neutrons required to have been emitted in the body to produce enough new C-14 at the 1988 sample location to shift the carbon from 33 AD to the midpoint of 1260-1390 AD. This would explain the 1988 carbon dating of the Shroud.

As shown in the above sequence of cause-and-effect relationships, the proton emission as it was oscillating between vertically up and down directions will cause an alternating current in the top fibers facing the body on both the front and dorsal images. An alternating current in any conductor will cause oscillating electric and magnetic fields in and around the conductor that force the electron flow to take place in the outer radius of the conductor. The higher the frequency of the alternating current, the thinner will be the outer radial region in which electrons are flowing. This is called the skin effect of an alternating current (https://en.wikipedia.org/wiki/Skin_effect). This will also apply to an alternating current in the flax fibers in the Shroud. Although a flax fiber would not normally be considered an electrical conductor, most materials will conduct electricity under extreme conditions. In this hypothesis, when the electrons flow in the thin outer radius of the fibers, the electrons will be hitting some of the atoms in this thin region around the circumference of the fibers. This will deposit heat in this thin region, which scorches the material to the color of a scorch; a straw-yellow or sepia color, as on the Shroud.

In summary, the Vertically Collimated Radiation Burst (VCRB) hypothesis for image formation can be stated as follows. A very brief high-frequency vertical oscillation of the nuclei in the dead body that was wrapped in the Shroud caused a small fraction of the deuterium nuclei in the

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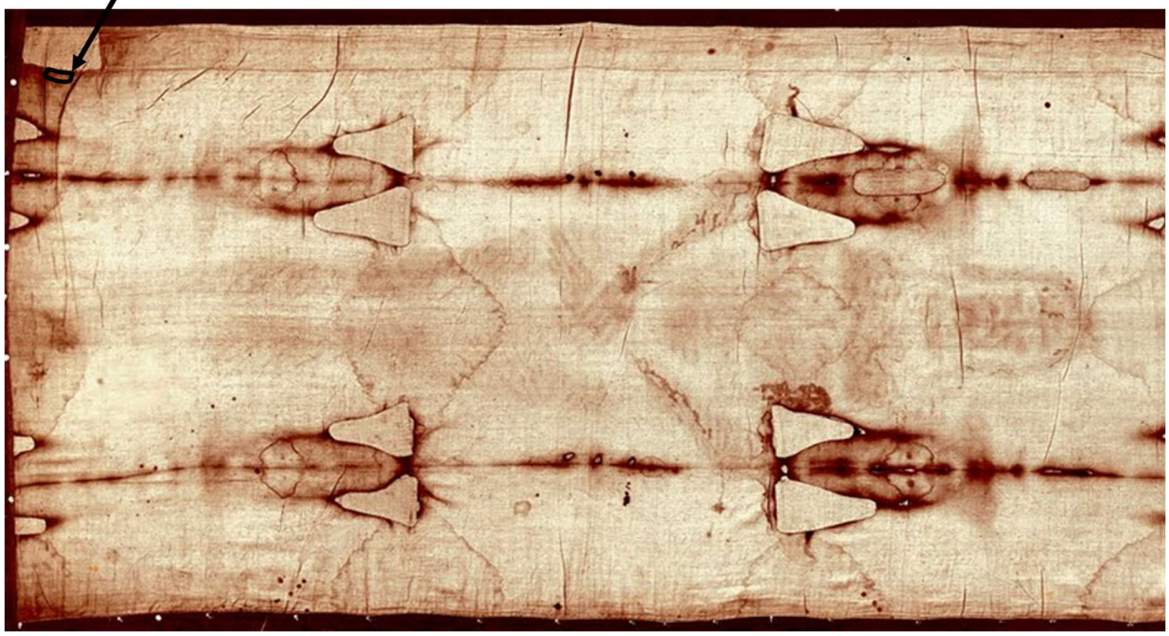
body to split, vertically emitting an equal number of protons and neutrons. This emission oscillated between vertically up and down directions. When the protons, oscillating between vertically up and down directions, deposited their electrical charge onto the cloth above and below the body, it caused alternating currents in the top fibers of the threads closest to the body. This alternating current caused the electrons to flow in the thin outer radial region around the circumference of the fiber by the "skin effect" of an alternating current, depositing heat there as the electrons collided with atoms in this thin outer radial region. This heat scorched the material in this thin region around the circumference of the fiber to the color of a scorch, a straw-yellow or sepia color, as on the Shroud.



Samples were Cut from the Corner of the Shroud in 1988

The question of what energy the protons had involves consideration of evidence 14 on page 9. Evidence 14 is "The density of ion tracks in the image fibers is about the same as the density of ion tracks in the non-image fibers." This observation was made by Ray Rogers. If this evidence is true, it only proves that if the images were caused by radiation, then the energy of the

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radiation had to be relatively low, below the threshold energy required to form ions. According to https://en.wikipedia.org/wiki/Ionizing_radiation, "different molecules and atoms ionize at different energies. The energy of ionizing radiation starts between 10 eV (electron-volts) and 33 eV." Thus, evidence 14 might be true because the energy of this radiation was below the energy threshold required to form ions in flax fibers. But if the energy of the protons is too low to make ion tracks in the fibers, only a very small fraction of the emitted protons would escape the body, and those that did would exhaust their energy by collisions with air molecules before they reached the cloth. However, these very low energy protons might still be transported to the cloth if there were a vertically oscillating electric field, perhaps one that either caused or was the result of the vertically oscillating nuclei in the body.

Another option is that perhaps Ray Rogers' observation that the image fibers and the non-image fibers had about the same density of ion tracks was the result of the fire that the Shroud experienced in 1532. This would be the case if the fire caused the temperature of the cloth to be high enough to cause the visibility of the ion tracks to be reduced sufficiently by annealing of the molecular damage in the ion tracks in the fibers. In general, ion tracks in fibers can be annealed by high temperatures, but experimental studies will probably be required to determine the extent of this for ion tracks produced by protons of various energies in linen cloth. If extensive annealing of the ion tracks had occurred due to a high temperature from the 1532 fire, then the energy of the protons emitted at the time of Jesus' resurrection could have been much higher, for example in the 1.2 to 1.5 Mev range without changing the ion track density that would have been visible in the fibers after the fire in 1532. This range of 1.2 to 1.5 Mev is the energy required to allow the protons to travel about 4 cm in normal air to reach the cloth, as required by previous studies (Ref. 9).

Carbon Dating of the Shroud in 1988

The process of carbon dating an object is performed by first taking one or more small samples from the object, because the material to be carbon dated must be burned. After the samples have been burned to reduce them to pure carbon, the ratio of C-14 to C-12 in the carbon is measured. A standard equation is then used to calculate the date from the measured C^{14}/C^{12} ratio. This equation assumes that the C^{14}/C^{12} ratio has only changed due to the decay of the C-14, which

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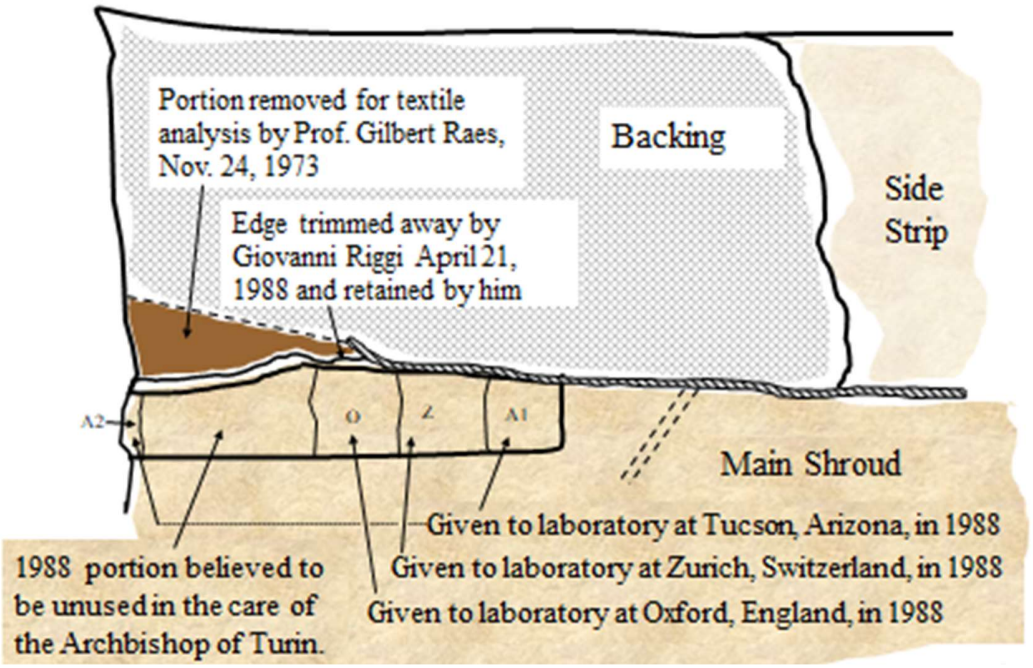
has a half-life of 5730 years. Based on the analysis below, it is believed that new C-14 was produced on the Shroud by neutron absorption. If this is true, then the assumption that the C^{14}/C^{12} ratio has only changed due to the decay of the C-14 is not valid. And if the equation to calculate dates from the C^{14}/C^{12} ratios is not valid, then these measured C^{14}/C^{12} ratios cannot be used to calculate a date. The possibility of them producing a believable date must be rejected.

FIGURE 7



Location of Samples for Carbon Dating of the Shroud

In 1988, a thin strip was cut from the corner of the Shroud for dating. When the Shroud is held horizontally with the front image to the left, the samples were cut from the upper left corner (Figure 6). These samples were sent to three carbon dating laboratories: Tucson in Arizona, Zurich in Switzerland, and Oxford in England (Figure 7). These laboratories cut their samples into smaller pieces so that ultimately 12 subsamples were carbon dated with each of the twelve dates having an

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uncertainty based on counting statistics and other considerations. Results of the carbon dating of these 12 subsamples are listed in Figure 8 based on Ref. 1. The carbon dates reported in Ref. 1 are in terms of years BP or "before present", where "present" is defined as the year 1950. Use of BP to indicate the year is standard procedure in the carbon dating industry, but in this paper, the years BP in Ref. 1 are translated into years AD as in Figure 8.

FIGURE 8

Oxford	Zurich	Tucson
1155 ± 65	1217 ± 61	1249 ± 33
1205 ± 55	1228 ± 56	1260 ± 35
1220 ± 45	1271 ± 51	1344 ± 41
	1311 ± 45	1359 ± 30
	1315 ± 57	
1200 ± 30	1274 ± 24	1303 ± 31

1260 ± 31 uncorrected
1260 to 1390 AD corrected

Measured Carbon Dates for the 12 Subsamples with Statistical Analysis

The statistical analysis of the carbon dates, based on the published values in Ref. 1, is shown in purple in Figure 8. The average or mean values for each laboratory (1200 ± 30, 1274 ± 24, and 1303 ± 31) shows a progression from an earlier date to a more recent date as the sample point is moved away from the short end of the cloth, i.e. toward the center of mass of the body, with a rate of change of about 36 years per cm (91

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years per inch), as discussed in Ref. 28. Averaging these laboratory mean values results in an average or mean rounded uncorrected value of 1260 ± 31 years. When this value is corrected for the changing C-14 content in the atmosphere, a rounded date range of 1260 to 1390 AD is obtained. This date range of 1260 to 1390 AD is based on an uncertainty range of two standard deviations which is equivalent to a 95% confidence that the correct value falls within this range. However, the correctness of this is based on the assumption that the 1260 ± 31 date is correct. Also, this date range of 1260 to 1390 AD could have also been stated in terms of one standard deviation which is equivalent to a 67% confidence, or a three standard deviation which is equivalent to a 99% confidence. But however this range is stated, the important point is that the corrected range of 1260 to 1390 AD (two standard deviations) is only correct if the 1260 ± 31 date (not corrected for the changing C-14 concentration in the atmosphere) is the correct average or mean value of the measured carbon dates for the 12 subsamples.

Most Shroud researchers believe this 1260 to 1390 AD date for the Shroud should be rejected, i.e., given no credibility. Reasons for this are the following:

1. The technology to produce the images did not exist in 1260 to 1390 AD. It does not exist today, even with all our computer and laser technology. This is why no one has successfully reproduced the Shroud's images both macroscopically and microscopically.

2. Many evidences indicate the Shroud was made earlier than 1260-1390 AD, including:

- Gold micro-particles on the Shroud from coins prior to about 1204 AD
- Diary of Robert de Clari in 1203 AD.
- Hungarian Pray Codex dated to 1192 to 1195 AD.
- Hand-spun thread used in the Shroud, prior to about 1200 AD.
- Coins containing an image of the face from the Shroud, 692 to 695 AD.
- Sudarium of Oviedo, believed to be Jesus' face cloth, about 570 AD.
- Paintings & works of art containing Jesus' face from the Shroud, 550 to 600 AD.
- Size of the Shroud, 8x2 cubits, with cubits being the ancient unit for measurement.
- Accurate depiction of crucifixion, though crucifixion was outlawed about 400 AD.
- Tradition Shroud was taken to Edessa, Turkey, prior to about 200 AD.

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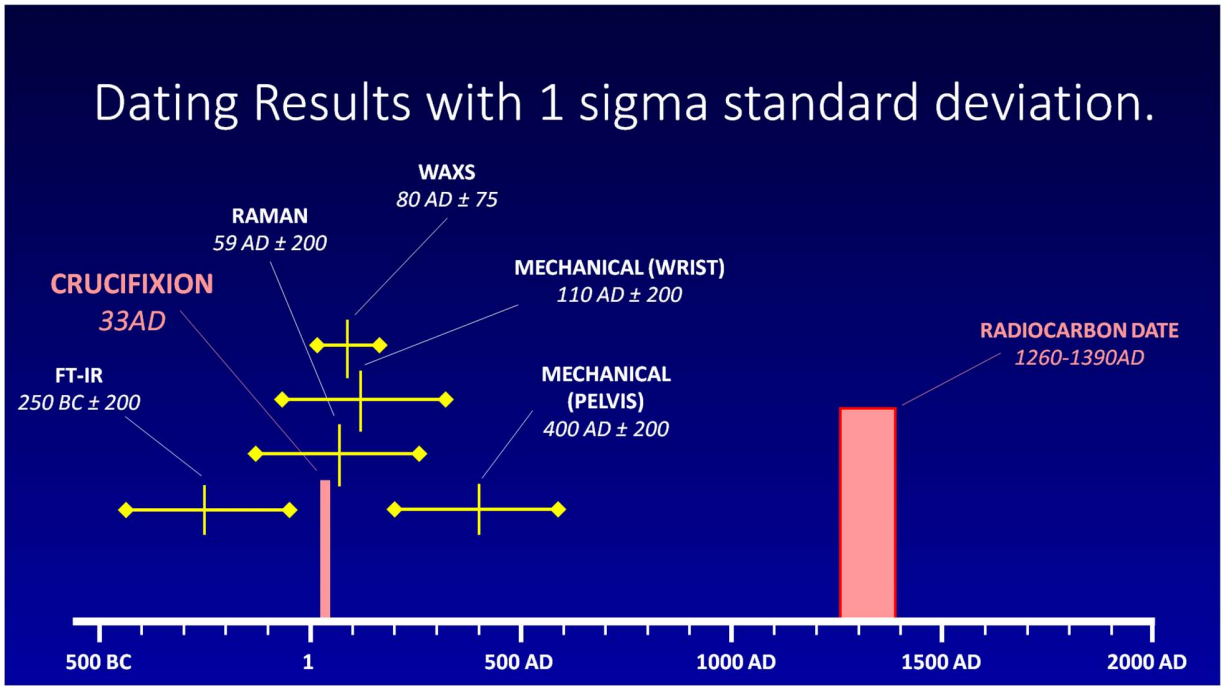
- Ancient stitch connecting the 3.2 inch side piece to the main Shroud, a similar stitch was used on a piece of cloth at Masada which was destroyed about 73 to 74 AD.
- Radiation damage on the Shroud's fibers is similar to that on the Dead Sea scrolls which are dated prior to about 74 AD.
- Image of Jesus on the Shroud, about 33 AD.

3. Recent new measurement techniques (Figure 9) indicate a date consistent with the time of Jesus, which is about 33 AD.

4. Statistical analysis of the measurement data in Ref. 1, as discussed below.

FIGURE 9



New Dating Techniques Contradict the Carbon Dating
by Michael Kowalski, 11-30-2023

But it is not sufficient to merely reject the 1260-1390 AD date for the Shroud. There also needs to be an explanation for why the three dating laboratories in 1988 produced this date range of 1260-1390 AD for the

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Shroud. The concepts that have been proposed to explain the measured carbon date of 1260-1390 are the following, in their approximate order of being proposed:

1. The neutron absorption hypothesis was proposed in 1989 by particle physicist Dr. Tom Phillips in the same edition of *Nature* that reported the results of the 1988 carbon dating of the Shroud (Ref. 1). Phillips proposed that neutrons absorbed in the Shroud would produce new C-14 on the fibers that would shift the carbon date measurement forward from the true date. No further work was done on this concept until nuclear analysis computer calculations were performed by the author in 2014.

2. Contamination due to handling of the Shroud during exhibitions, or due to intentionally putting materials such as wax or talc onto the Shroud to strengthen it.

3. Heat or smoke due to the Shroud being in a fire in 1532 AD in Chambery, France.

4. Bioplastic film left on the fibers due to the normal action of bacteria. Concepts 2, 3, and 4 are not commonly advocated now because these forms of contamination would have to be over 65% of the mass of the samples to produce a measured carbon date of 1260-1390. Visual inspection indicates these sources of contamination are not present in anywhere near this amount.

5. The invisible reweave hypothesis was proposed by Joe Marino in 2000. In this hypothesis, French "invisible" reweave technology was used in the early 1500s to repair the corner of the Shroud where in 1988 the samples were cut from the Shroud for carbon dating. This involved weaving dyed cotton into the original linen fabric at the corner in such a careful manner that the resulting reweave cannot be seen. Thus, the samples that were carbon dated consisted of a mixture of new (about 1520 or 1540 AD) and old (about 33 AD) material, resulting in the 1260-1390 carbon date.

6. Carbon monoxide absorption hypothesis proposed by Dr. John Jackson. This hypothesis has largely been dropped due to lack of evidence for this mechanism, and other fabrics not being affected by it.

To prove the accuracy of their equipment, materials, procedures, and personnel during the carbon dating of the Shroud, the three dating laboratories also did carbon dating of three control standards for which they knew the historical dates. Since the measured carbon dates for the three control standards were determined with reasonable accuracy, it should be accepted that the C^{14}/C^{12} ratio measurements for the twelve Shroud

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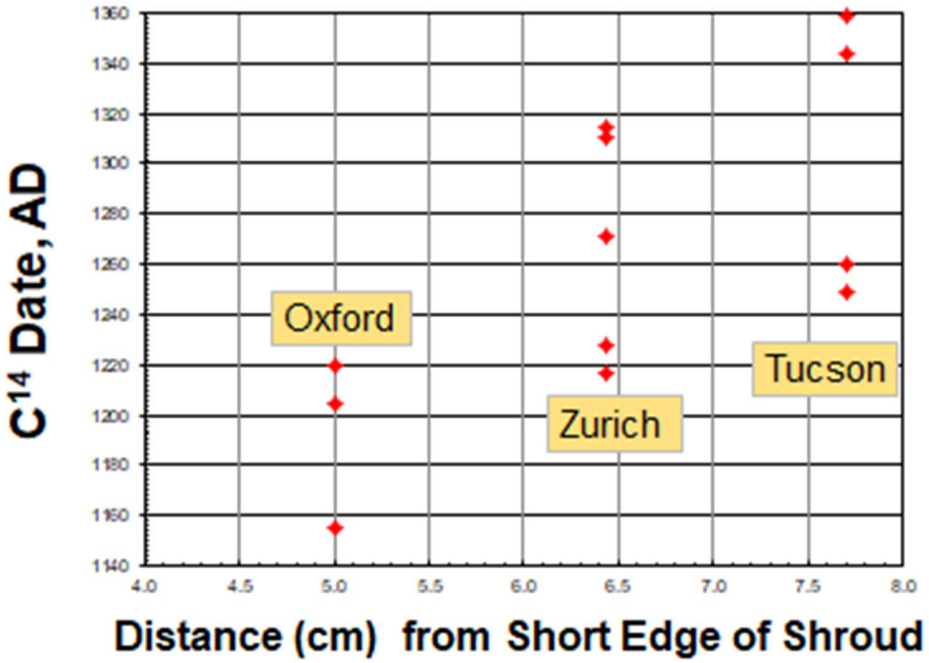
subsamples were also correct. As a result, the spatial dependence of the carbon dates for the Shroud must result, not from an error in the measurements of the C^{14}/C^{12} ratio, but from something that altered the C^{14}/C^{12} ratios in the twelve subsamples as a function of their location. As discussed above, of the above six proposed options for explaining the carbon dating of the Shroud, only the neutron absorption hypothesis (#1) and the invisible reweave hypothesis (#5) are now considered to be viable options by Shroud researchers. There are multiple objections against the invisible reweave hypothesis as discussed in section 10 of Ref. 28. Due to these objections, the neutron absorption hypothesis (#1) deserves further consideration.

FIGURE 10



Carbon Dates are in High and Low Pairs

When the carbon dates for the 12 subsamples are plotted as a function of the distance from the short end of the cloth, with the values plotted at the center of each of the three sample areas, the result is Figure 10. This

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figure shows that the dates increase from left to right and appear in high and low pairs. This is difficult to explain unless it is realized that these measured dates are the result of both the true date of the Shroud, i.e. about 33 AD, and the neutron distribution in the tomb, with a small fraction of the neutrons that were emitted in Jesus' resurrection being absorbed in N-14 to produce new C-14 on the cloth. This is important because it is the C^{14}/C^{12} ratio that is measured in carbon dating. In Figure 10, the increase from left to right is the result of the distribution of neutrons in the horizontal direction (X-direction) in Figure 7 due to the neutrons that were emitted throughout Jesus' body in his resurrection, with the carbon dates occurring in high and low pairs because of the neutron distribution in the vertical direction (Y-direction) in Figure 7. The neutron flux (neutrons/cm2-sec) decreases as the distance increases from the centerline of the body, so that the higher date in the pair in Figure 10 is from a position closer to the centerline of the body and the lower date is from a position further from the centerline of the body. This realization allows the subsample sizes and locations to be estimated based on their carbon dates compared to the neutron distributions in the tomb. The proposed subsample sizes and locations are shown in Figure 11, with the higher carbon dates across the top of the sample area and the lower carbon dates across the bottom of the sample area, with a general slope upward in the dates from the left to the right. This is an initial proposal for the subsample sizes and locations, since no information regarding how the samples were cut into subsamples has previously been available. Future consideration regarding the size and location of each subsample may result in some changes from that shown in Figure 11.

The author's previous conclusions (Ref. 28) regarding the 1988 carbon dating of the Shroud are the following: 1) the stated average carbon date of 1260 to 1390 AD should be rejected, i.e. given no credibility, due to the presence of a systematic measurement error that caused the twelve subsample dates to be heterogeneous (not consistent with each other within their uncertainties), as though they were not related to one another, and 2) the best explanation for the carbon dating of the Shroud is that neutrons were emitted from the body, with a small fraction of them being absorbed in N-14 to produce new C-14 atoms on the cloth by the [N^{14} + neutron produces C^{14} + proton] reaction. These new C-14 atoms produced on the cloth would have shifted the measured carbon date forward from the true

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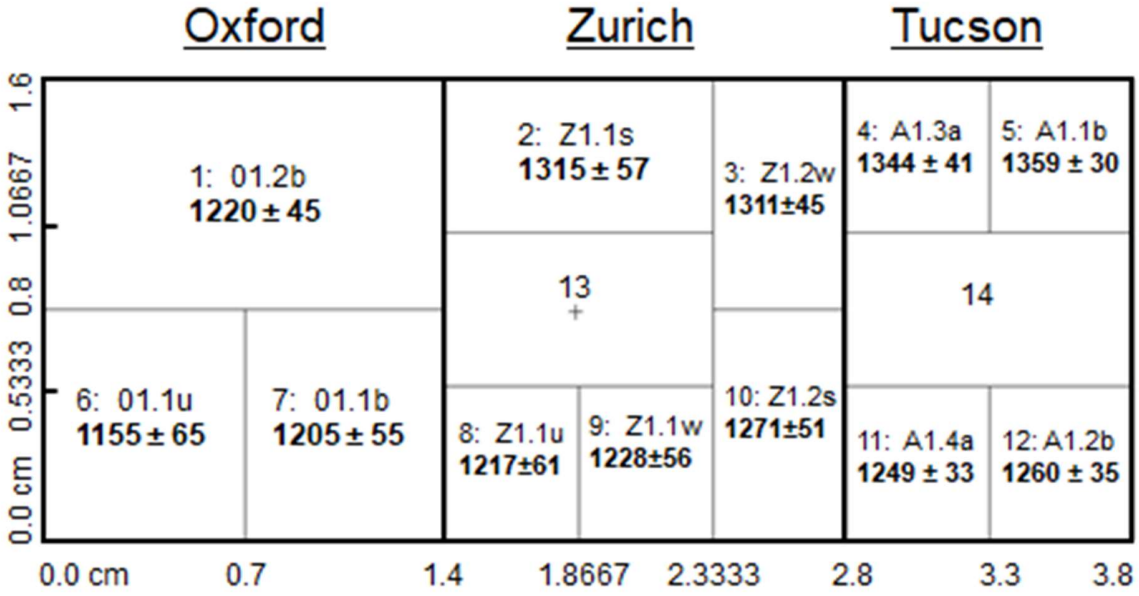
date to the range of 1260-1390 AD. This production of new C-14 atoms on the cloth by neutron absorption caused the systematic measurement error that is evident in the measurement data from carbon dating in Ref. 1. This explanation is called the neutron absorption hypothesis. This explanation is the only hypothesis that can be consistent with the four things we know to be true about carbon dating related to the Shroud:

1. The average or mean carbon date is 1260 ± 31 (uncorrected value).
2. The change in the carbon date as it depends on the distance from the short edge of the Shroud is about 36 years per cm (91 years per inch).
3. The distribution (1155 to 1359 AD) of the measured carbon dates for the twelve subsamples.
4. The measured carbon date of about 700 AD for the Sudarium of Oviedo, which is believed to be Jesus' face cloth.

FIGURE 11



Proposed Pattern for Cutting the 12-Subsamples,
with Measured Carbon Dates in Bold Black

Use of the MCNP (Monte Carlo N-Particle, where N is for Neutrons) computer code in 2013 and 2014, documented in Ref. 28, indicated that

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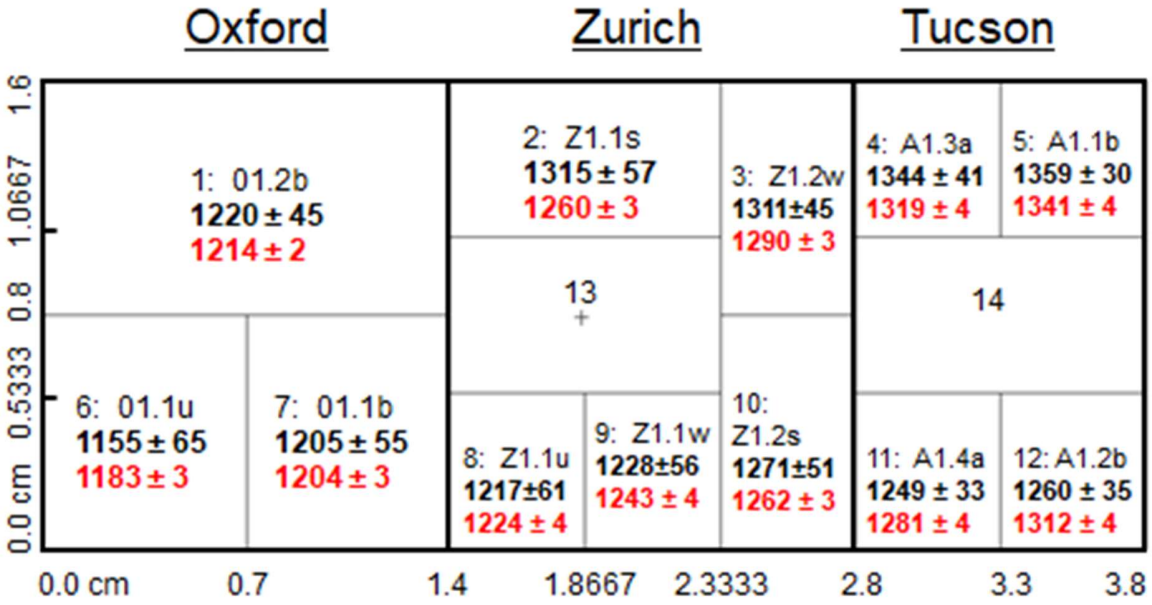
the neutron absorption hypothesis is consistent with #1, #2, and #4 above. Additional MCNP calculations were needed to prove it is consistent with #3 because the subsamples are much smaller than the samples, and because there is no documentation how the samples were cut into the subsamples. This was evidently not considered to be an important issue in the process of carbon dating the Shroud in 1988.

FIGURE 12



MCNP Calculated Neutron Distributions Produce
Carbon Dates (in red) that are in Good Agreement with
the 1988 Measured Carbon Dates (in black)

MCNP is standard computer software used in the nuclear industry for design of nuclear reactors, radiation detectors and shielding design, for medical purposes, etc. It was developed over five or six decades by a team of programmers at the Los Alamos National Laboratory in New Mexico, US. It has been fully verified and validated to the requirements of US government regulations based on comparison of thousands of MCNP calculations with experiments in nuclear facilities.

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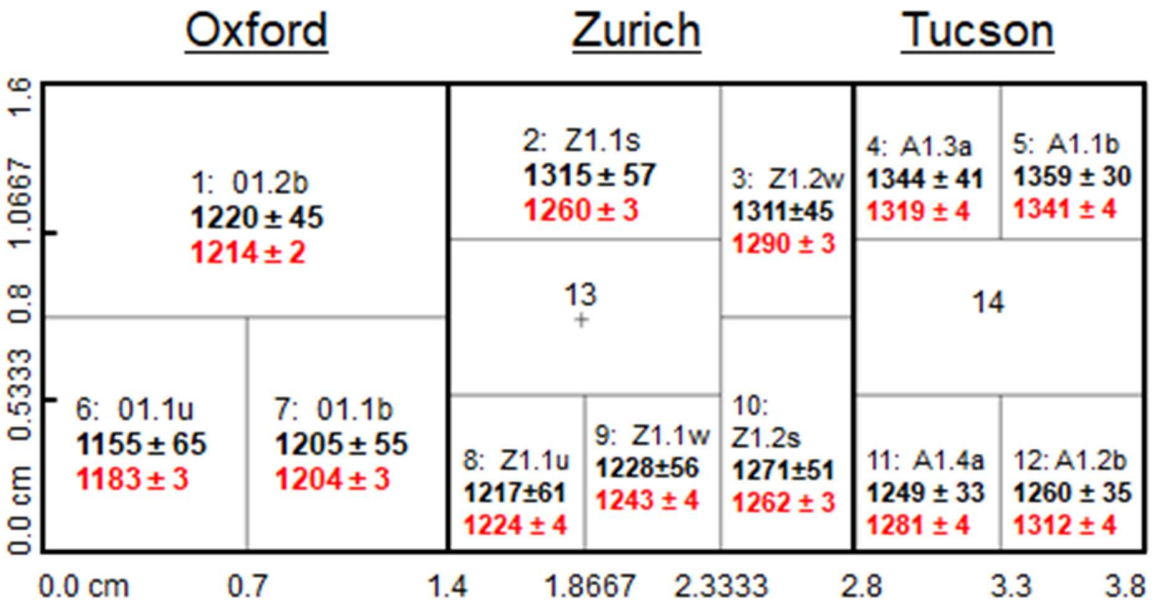
FIGURE 13



Comparison if the Shroud was made in 1260 AD,
Measured Carbon Dates in Bold Black, Predicted Dates in Red.

In 2025, additional MCNP calculations were run to determine whether #3 above (distribution of the carbon dates for the 12 subsamples) would also be satisfied by the neutron absorption hypothesis, i.e. whether the MCNP calculated carbon dates for the 12 subsamples would have a distribution that was in good agreement with the 1988 measured dates. The proposed subsample sizes and locations in Figure 11 were used in new MCNP calculations of the carbon dates for the 12 subsamples.

In Figure 12, the 1988 measured carbon dates for the 12 subsamples are shown in black and the results of the new MCNP calculations are shown in red. The carbon dates calculated in MCNP, shown in red in Figure 12, assume that neutrons were emitted homogeneously from the body in Jesus' resurrection and that the Shroud was made in 33 AD.

There appears to be good agreement in Figure 12 between the MCNP calculations in red and the 1988 measured dates in black. But the

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question is whether this agreement is any better than the agreement between the 1988 measured dates and an assumption (Medieval Shroud hypothesis) that the Shroud was made in the Middle-Ages between 1260 and 1390 AD and that no neutrons were emitted from the body. Thus, there are two different hypotheses to explain the distribution of the carbon dates that were measured in 1988: 1) the Medieval Shroud hypothesis (figure 13) assumes naturalism, so that the distribution of the carbon dates measured for the 12 subsamples is simply due to the Shroud being fabricated during the period of 1260 to 1390 plus the random measurement process used in the 1988 measurements, and 2) the neutron absorption hypothesis (Figure 12) which assumes neutrons were emitted during Jesus' resurrection, so that the 1988 measured carbon dates result from the true date for the Shroud being 33 AD plus new C-14 produced on the cloth from neutron absorption based on the neutron distributions in the tomb, with allowance for the random measurement process used in the 1988 measurements. These two options are considered below to determine which is in better agreement with the distribution of the 1988 measured dates for the 12 subsamples.

To determine whether the Medieval Shroud hypothesis or the neutron absorption hypothesis is in better agreement with the measured dates, the appropriate methodology is to calculate the chi-squared value for each hypothesis and then compare the results. The chi-squared value is obtained by calculating the square of the difference between the measured value and the predicted value for each of the 12 subsamples and then adding them to get the total:

chi-squared = $(MV1 - PV1)^2 + (MV2 - PV2)^2 + (MV3 - PV3)^2 + \ldots + (MV12 - PV12)^2$ where MV = Measured Value and PV = Predicted Value for the 12 subsamples

FIGURE 14

					Renormalized	
		Measured	Medieval Shroud Date		Neutron absorption	
	Sub-	Carbon	Predicted	Chi-	Predicted	Chi-
	Sample	Date	Date	squared	Date	squared
	1	1220	1261.17	1.343751	1214.03	2.9332E-02
	2	1315	1261.17	2.297894	1260.17	2.3857E+00

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	3	1311	1261.17	1.969098	1290.13	3.3776E-01
	4	1344	1261.17	5.440487	1318.75	4.8358E-01
	5	1359	1261.17	7.589291	1341.44	2.2979E-01
	6	1155	1261.17	8.937249	1183.47	6.8482E-01
	7	1205	1261.17	2.501410	1203.95	9.1763E-04
	8	1217	1261.17	1.546738	1223.54	3.4936E-02
	9	1228	1261.17	0.872230	1243.48	1.9262E-01
	10	1271	1261.17	0.076671	1262.18	6.1617E-02
	11	1249	1261.17	0.117374	1280.85	7.9183E-01
	12	1260	1261.17	0.001079	1312.02	2.0627E+00
	Sum =	15134.00	15134.00		15134.00	
	Average =	1261.17	1261.17		1261.17	
Total chi-squared =				32.69		7.30
Medieval Shroud/MCNP ratio =						4.48

Carbon Dates for the 12 Subsamples for an 81.2/18.8 Mix of New (1520 AD) and Old (33 AD) Material

The neutron absorption hypothesis assumes that the Shroud dates to 33 AD and that neutrons were emitted homogeneously from Jesus' body in his resurrection. A small fraction of these neutrons would have been absorbed in the trace amount of N-14 in the cloth that would have produced new C-14 in the fibers. This neutron absorption hypothesis was used in MCNP to calculate the carbon dates in red in Figure 12. The Medieval Shroud hypothesis is shown in Figure 13 with the predicted date being the same for all of the 12 subsamples. The predicted date shown in Figure 13 is the rounded date of 1260 though the value of 1261.17 is used in Figure 14, since the simple average of the measured carbon dates for the 12 subsamples is 1261.17. How the chi-squared value is calculated for the Medieval Shroud hypothesis and for the neutron absorption hypothesis is shown in Figure 14. To minimize the chi-squared value for the Medieval Shroud hypothesis, it was assumed that the Shroud was made in 1261.17 AD (uncorrected date), so that the predicted carbon date for every location on the Shroud is 1261.17 AD. The resulting chi-squared value for the Medieval Shroud hypothesis is 32.69 as shown in Figure 14.

Calculating the chi-squared value for the neutron absorption hypothesis,

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with the predicted value being the MCNP calculated date (renormalized to an average of 1261.17), gives a value of 7.30 as shown in Figure 14. This proves that the chi-squared value is a factor of 4.48 lower for the neutron absorption hypothesis than for the Medieval Shroud hypothesis. This indicates that the neutron absorption hypothesis is in much better agreement with the 1988 measured carbon dates than the Medieval Shroud hypothesis, so that the neutron absorption hypothesis is more likely to be true than the Medieval Shroud hypothesis. This is because a hypothesis, to be true, must agree with the evidence, which in this case is the carbon dates measured for the 12 subsamples in 1988. However, as stated in the first section of this paper, the final basis for determining which hypothesis is true will be whether predictions made by each hypothesis will be proven to be true when tested.

The MCNP calculated values in red in Figure 12 assume the sizes and locations, relative to each other, of the 12 subsamples shown in Figure 12. Also assumed is the location of the group of 12 subsamples at the instant of the burst of radiation from the body, which is best understood to have occurred in Jesus' resurrection. But since the exact location of the group at the instant of Jesus' resurrection is not known, this issue had to be investigated by assuming many different locations for this group of 12 subsamples. To accomplish this, MCNP was used to calculate carbon dates for 81 locations of this group of 12 subsamples. The MCNP calculated carbon dates at the group's position that gave the best fit to the measured carbon dates is shown in Figure 12. It is likely that additional MCNP calculations for other locations of the group of 12 subsamples at the instant of the radiation burst will produce an even better agreement with the measured carbon dates than shown in Figure 12, and will thus produce a smaller value for chi-squared than the value of 7.30 in Figure 14. When this location for the group of 12 subsamples is found that produces the minimum chi-squared value, it will then be included in the VCRB hypothesis as the most likely position of the group of 12 subsamples at the instant of Jesus' resurrection. This optimization process to determine the best hypothesis that produces the best fit to the evidence is often used in the scientific method, for example in determining the best hypothesis to explain the current characteristics of the solar system or the current location of the galaxies in the universe.

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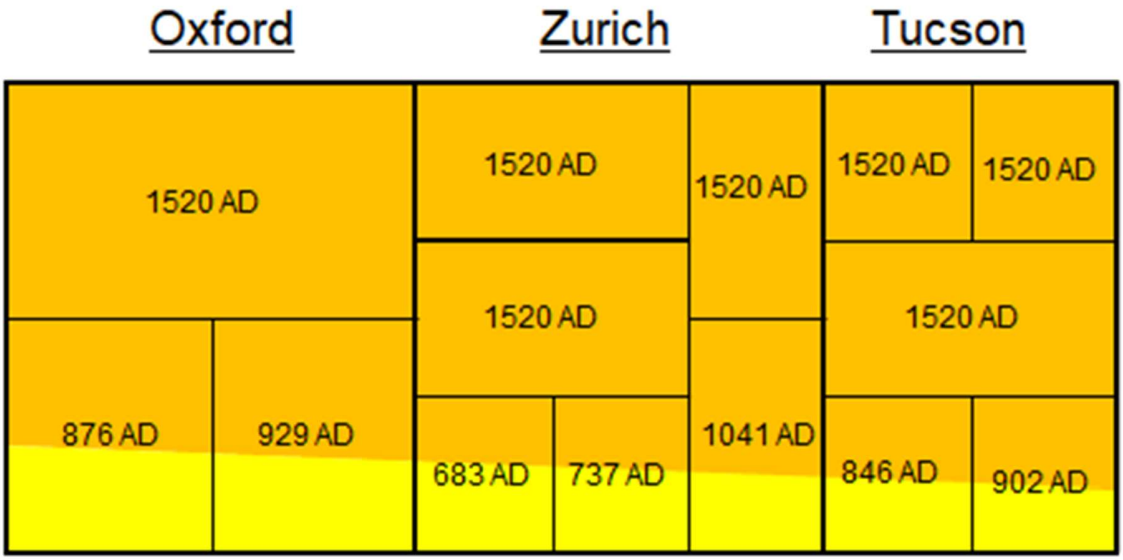
FIGURE 15



Carbon Dates for the 12 Subsamples for an 81.2/18.8 Mix
of New (1520 AD) and Old (33 AD) Material

To explain the measured carbon dates by the invisible reweave or patch hypothesis is probably not credible when the carbon dates for the 12 subsamples is considered, because the measured range is from 1155 to 1359 AD (Figure 8). For example, application of the invisible reweave hypothesis to a realistic pattern of the subsamples (Figure 11) results in the carbon dates for all the 12 subsamples being outside of the measured range of 1155 to 1359 AD (Figure 15).

Conclusion

The Vertically Collimated Radiation Burst (VCRB) hypothesis was developed based on consideration (Ref. 23) of 27 different evidences related to the images on the Shroud. This hypothesis proposes that the root cause of the front and dorsal images on the Shroud is a very short duration high frequency vertically oriented oscillation of the nuclei in the dead body that was wrapped in the Shroud. This oscillation of the nuclei caused about 0.0004% of the deuterium nuclei to split releasing an equal number of protons and neutrons. The protons

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deposited their electrical charge on the sections of the cloth above and below the body, producing an alternating current in the top fibers facing the body, which deposited heat in a thin region less than one micrometer thick around the circumference of the image fibers. This heat scorched the material in this thin region to discolor it to a straw-yellow or sepia color, which is the color of a scorch.

The neutrons released by the splitting deuterium nuclei spread throughout the tomb, with a small fraction of them being absorbed in the trace amount of N-14 in the fibers to produce new C-14 in the fibers by the [N^{14} + neutron produces C^{14} + proton] reaction. This new C-14 produced by neutron absorption shifted the carbon dates for the 1988 samples to the future, relative to the true date, since carbon dating is based on measurement of the C^{14}/C^{12} ratios. This is the only proposed concept that is consistent with all the evidence related to the carbon dating of the Shroud: 1) the mean carbon date of 1260-12390 AD, 2) the change in the carbon date as a function of the distance from the short end of the cloth of about 36 years per cm (91 years per inch), 3) the distribution of the measured carbon dates for the 12 subsamples that were dated, and 4) the carbon date of about 700 AD for the Sudarium of Oviedo which is believed to be Jesus' face cloth in John 20:7. The deviation of the MCNP calculated carbon dates for the 12 subsamples from the 1988 measured dates is 4.5 less than the deviation produced by assuming the Medieval Shroud hypothesis, with the Shroud made in 1260 and no neutrons emitted from the body. Thus, the neutron absorption hypothesis is much more consistent with the evidence than the Medieval Shroud hypothesis. The invisible reweave hypothesis is very unlikely to be a credible explanation for the measured carbon dates of the 12 subsamples.

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