Proposal for C^{14} Dating of Charred Material Removed from the Shroud

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Rev. 1, October 15, 2018

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Abstract

In 1988 the Shroud was carbon-14 (C^{14}) dated to 1260 to 1390 AD (Ref. 1), but other evidence (Ref. 2) is consistent with a first century date for the Shroud. To resolve this discrepancy, this proposal recommends that C^{14} dating be done on samples of the charred material removed from the Shroud in 2002. Nuclear analysis computer calculations based on the neutron absorption hypothesis were used to predict the measured dates for this charred material, as shown in Figure 1. If there is reasonable agreement between the measured dates and the predictions in Figure 1, i.e. about AD 3100 to AD 4800 for samples near the elbows, it would indicate that neutrons were absorbed by the linen, producing additional C^{14} in the Shroud. This new C^{14} would explain why the Shroud was C^{14} dated to 1260 to 1390 AD instead of the first century.

Objective

To determine whether the 1988 dating of the Shroud to the Middle Ages can be explained by the neutron absorption hypothesis.

Hypothesis

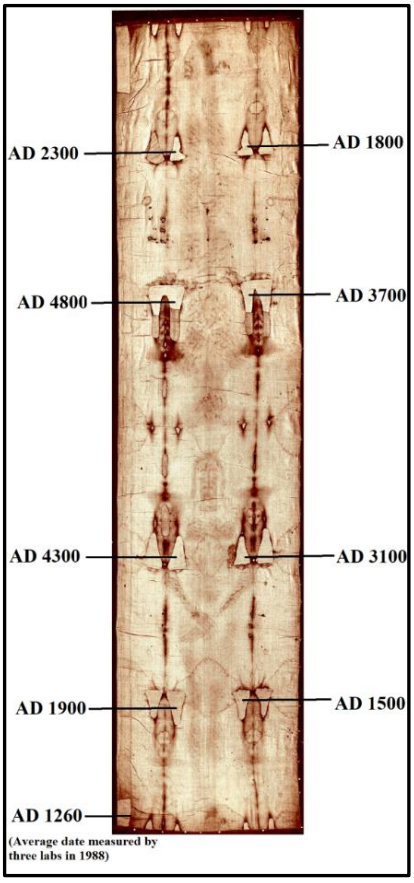
The neutron absorption hypothesis (Ref. 2 to 4) is:

1. Neutrons were included in the burst of radiation emitted from within the body that formed the image.
2. Some of these neutrons would have been absorbed in the linen to form new C^{14} atoms on the Shroud.
3. This increase in the number of C^{14} atoms on the Shroud would have shifted the C^{14} date forward by up to thousands of years, depending on the location on the Shroud.

Computer calculations indicate that the neutron absorption hypothesis is consistent with the four things that we know about C^{14} dating related to the Shroud:

1. The average date at the 1988 sample location was AD 1260.
2. The slope at the 1988 sample location was 36 years per cm.
3. The range of the 16 measurements was AD 1155 to 1410.

Figure 1. C^{14} Dates Predicted by MCNP



4. The C^{14} date for the Sudarium of Oviedo was AD 700.

Thus, it is reasonable to expect that the neutron absorption hypothesis should also make accurate predictions of the C^{14} dates at other locations. According to Figure 1, much of the charred material taken from under the patches in 2002 should C^{14} date far into the future, making the neutron absorption hypothesis easily testable.

Significance

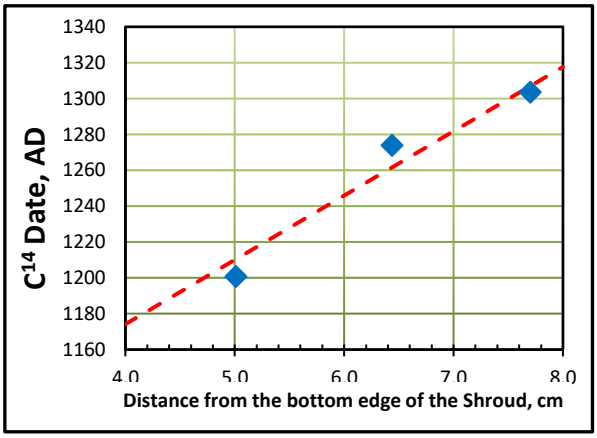
The charred material to be tested requires only small pieces that have already been removed from the Shroud. Thus, there would be no negative physical impact on the Shroud, yet there could be a significant positive impact on our understanding of it. This could be the definitive experiment to explain the 1988 date to the Middle Ages and thus help to determine whether the Shroud could be the authentic burial cloth of Jesus.

Introduction

Most Shroud researchers agree that historical and scientific research on the Shroud of Turin is consistent with it being the authentic burial cloth of Jesus (Ref. 5 and 6), with the main exception being the 1988 dating of the Shroud to the Middle Ages (AD 1260 to 1390). The first proposed solution for this discrepancy was neutron absorption in the Shroud (Ref. 7). This proposal appeared in 1989 in the same volume of the British journal *Nature* in which the statistical analysis of the C^{14} measurement data also appeared (Ref. 1). Much research has been done on neutron absorption in the Shroud since its first introduction (Ref. 8 to 13). Several other explanations were subsequently proposed and considered, with objections recognized (Section 2 of Ref. 4). The invisible reweave hypothesis is currently the most common explanation, but objections to this concept have also been raised (Ref. 8). The neutron absorption hypothesis is a better explanation for the C^{14} dating discrepancy because:

- It is consistent with everything that we know about C^{14} dating as it relates to the Shroud.
- It is very testable, since it predicts the C^{14} date that would be obtained at any location on the Shroud.

Figure 2. C^{14} Dates Measured by Oxford, Zurich, and Arizona



Background

In 1988 samples were cut from the bottom left corner of the Shroud and sent to three laboratories for C^{14} dating. The average date from the three laboratories was AD 1260. When this value was corrected for the changing C^{14} in the atmosphere, a range of AD 1260 to 1390 was obtained. Based on these values it was concluded in 1989 (Ref. 1) that "the linen of the Shroud of Turin is medieval." However, there were significant inconsistencies in the measurement data

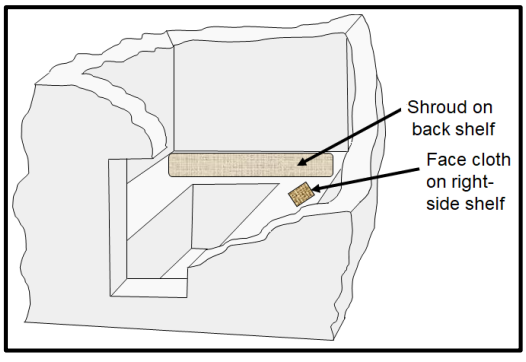
which bring into question this conclusion (Ref. 3). The average values obtained by the three laboratories were: Oxford AD 1200, Zurich AD 1274, and Tucson AD 1304. The sample locations were 5.0, 6.5, and 7.7 cm, respectively, from the bottom edge of the Shroud. This data is plotted in Figure 2 and shows a slope of about 36 years per cm. The slope indicates that something likely caused a progressive increase in the C^{14} content of the samples the further they were from the bottom edge of the cloth. This suggests that every location on the Shroud could C^{14} date to a different value. This contradicts the basic assumption of the 1988 measurement process and analysis that assumed every location on the Shroud would date the same. Thus, doubt is cast upon the 1988 conclusion that the Shroud is medieval. It should be made clear that the measured C^{14} content of the samples is not being questioned. Rather, the statistical analysis of the results was inadequate, because the addition of new C^{14} to the cloth was not considered a possibility.

To understand how C^{14} could have been added to the cloth, it is necessary to consider the uniqueness of the Shroud image. It was scientifically proven by STURP in 1978 that the image on the Shroud is not due to pigment, scorch, photography, or any other normal process. Most experts on the Shroud have concluded that the image was caused by the body that was wrapped within the cloth (Section 3of Ref. 6). The discoloration mechanism that formed the image required energy to drive it and information to control it. The required information is that which defines the appearance of a crucified man. This information was not inherent to the limestone or air in the tomb. It was only inherent to the body which was wrapped within the cloth. This information had to be communicated from the body to the cloth. Of the several ways that information can be transferred from one location to another, radiation is likely the only option that applies to the Shroud (Ref. 16). In *Role of Radiation in Image Formation on the Shroud of Turin*, seventeen evidences are discussed for a burst of radiation being emitted from within the body to form the image (Ref. 17). This radiation could have included ultraviolet and/or charged particles, such as protons, to form the image. Since 45% of a human body by weight is neutrons, neutrons could have also been included in this radiation. If neutrons were included in this radiation, a small fraction of them would have been absorbed in the N^{14} in the cloth to form new C^{14} atoms by the (N^{14} + neutron → C^{14} + proton) reaction. For example, if the C^{14} density on the Shroud at the sample location was increased by only 16% it would shift the C^{14} date from AD 30 to AD 1260.

Nuclear Calculations

Based on the neutron absorption hypothesis, detailed nuclear analysis computer calculations were performed (Ref. 4) using the MCNP (Monte Carlo Neutron Particle) software (Ref. 18), which is commonly used in the nuclear industry. It was developed at the Los Alamos National Laboratory over the last six decades and has been qualified to NRC (US Nuclear Regulatory Commission) and DOE (US Department of Energy) standards by comparison of thousands of nuclear experiments with results of MCNP calculations. MCNP operates by following one neutron at a time through the

Figure 3. Limestone Tomb Modelled in MCNP



defined geometry, which in this case modelled a 77.1 kg (170 pound) body wrapped in a linen cloth lying on the back shelf of a limestone tomb as it would have been designed in first century Jerusalem (Figure 3). In 2014, over 400 MCNP calculations were run during a five-month period with most calculations following 30,000,000 neutrons to reduce uncertainties. Typical calculations ran for 6 to 13 hours each on the computer. Results of selected cases from these MCNP calculations were reported at the Shroud conferences in St. Louis in October of 2014 and in Pasco, WA in July of 2017.

These MCNP calculations determined that if 2 x 10^{18} neutrons were emitted from within the body, it would cause the C^{14} date for the 1988 Shroud samples to be shifted from AD 30 to AD 1260. Since there would have been about 2 x 10^{28} neutrons in the 77.1 kg (170 pound) man wrapped in the cloth, only one neutron in every 10 billion (1 x 10^{10}) had to be emitted from the body to cause this shift in the date.

The MCNP calculations indicate that the neutron absorption hypothesis is consistent with all four things known about C^{14} dating as it relates to the Shroud:

1. The average date from the three laboratories at the 1988 sample location was AD 1260.
2. The slope at the 1988 sample location was about 36 years per cm based on a plot of the average values from the three laboratories, as shown in Figure 2.
3. The range of the dates measured for the 16 subsamples was AD 1155 to AD 1410.
4. The measured C^{14} date for the Sudarium of Oviedo was AD 700. MCNP calculates this same date if the Sudarium were placed on the right-side shelf in the tomb about a foot in front of the back shelf. Many believe the Sudarium to be the face cloth of Jesus mentioned in John 20:7.

Figure 4. C^{14} Dates on the Cloth Below the Body Calculated by MCNP

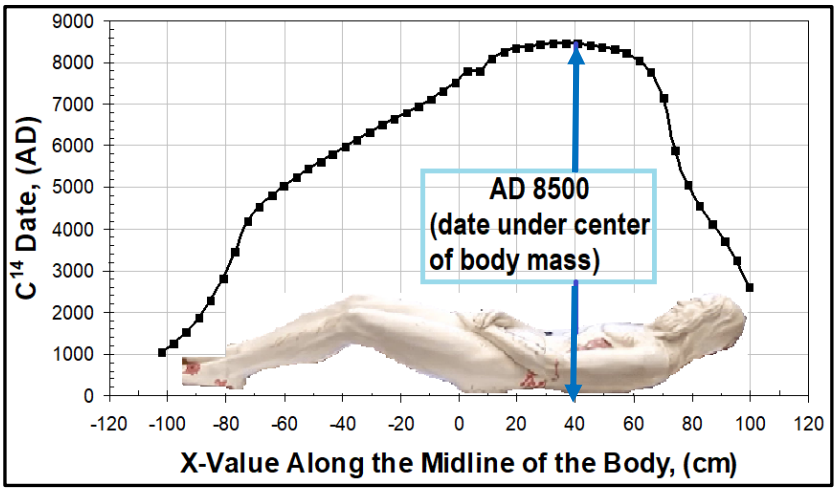


Figure 4 shows the distribution of the C^{14} dates calculated in MCNP along the midline of the cloth under the body. The second point from the left side of the plot is AD 1260, which is the average of the three laboratory values. The plot reaches a maximum C^{14} date of AD 8500 below the center of mass of the body. The MCNP calculated dates under the elbows would be in the range of about AD 3100 to AD 4800, as shown in Figure 1. In C^{14} dating, dates to the future can

be obtained when more C^{14} is measured than is present in a living plant. This is predicted for the Shroud because of new C^{14} produced on the Shroud due to neutron absorption. The difference between the values on the left side versus the right side in Figure 1 is due to neutrons reflected from the vertical limestone wall next to the body as it lay on the back shelf and depends on which direction the head was facing. Because many of the predicted dates are into the future, the neutron absorption hypothesis used in the MCNP calculations can be easily tested by dating the carbonized material removed from the Shroud.

Conclusion

The 1988 dating of the Shroud to the Middle Ages caused widespread disbelief in its authenticity which diminished further research. This proposal offers the opportunity to solve the 1988 dating discrepancy using a hypothesis that is consistent with everything that is known about C^{14} dating as it relates to the Shroud. If dates for the charred material are obtained that are far into the future, i.e. about AD 4000 near the elbows, it would disprove the 1988 dating of the Shroud to the Middle Ages and cause many to reconsider the Shroud's authenticity. Dating of the charred material will do no physical damage to the Shroud because the charred material now resides in 42 sample jars in Turin. Those doing Shroud research are available to answer questions and provide other relevant information, such as procedures to accomplish the dating process.

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Biography

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