Testing the Neutron Absorption Hypothesis

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Abstract

Any hypothesis proposed to explain a phenomenon should be consistent with the known characteristics of the phenomenon and make predictions that can be experimentally verified or falsified. The neutron absorption hypothesis is consistent with the four known characteristics of the carbon dating of the Shroud of Turin: the date, slope, and range of the 1988 carbon dating and the 700 AD carbon date for the Sudarium. Testable predictions of the neutron absorption hypothesis include the carbon date that should be obtained for any other location on the Shroud and the quantities of long half-life isotopes that could still be measurable on the Shroud.

Discussion

In trying to explain any kind of scientific phenomena, the first step is to develop a hypothesis that is consistent with all the characteristics of the phenomena. The hypothesis is then used to make predictions which are then tested so that the hypothesis could be falsified. Every positive result that confirms a prediction enhances the credibility of the hypothesis. A negative result falsifies the hypothesis. The four characteristics of carbon dating as it relates to the Shroud are the date (1260 ± 31), slope (36 to 38 years per cm), and range (1155 to 1376 AD) of the 1988 carbon dating measurements (Ref. 1), as well as the carbon dating of the Sudarium to 700 AD, since the Sudarium is believed to be related to the Shroud. The fraud/artistic hypothesis, and any contamination hypothesis, could be consistent with only two of the four characteristics: the date of the Shroud and date of the Sudarium, if it is assumed that the Sudarium is either a fraud, an artistic work, or is largely composed of contamination. But the fraud/artistic hypothesis and any contamination hypothesis would not be consistent with the slope or range of the 1988 measurement data.

The invisible reweave hypothesis can be consistent with the date and slope (assuming the mix of new and old material is a function of position) of the 1988 measurement data, but not the range of the 1988 data or the 700 AD date for the Sudarium. Regarding the range of the data for the invisible reweave hypothesis, the subsamples used in the 1988 carbon dating would have been randomly cut from the samples sent to the laboratories. Cutting of the subsamples from the samples would have been a random process because there would have been no concern regarding the orientation of the samples as they were being cut. Considering the four sides of each sample according to the invisible reweave hypothesis, one side would have been only old material, one side would have been only new material, and two sides would have been part new and part old material. The random cutting of the subsamples means that the probability of any given subsample to be a mixture of new and old material is (2 sides/4 sides) = 0.5. The probability that all 16 subsamples would be a mixture of both old and new material would therefore be 0.5 to the 16^{th} power = 0.0000153. This is the same probability as flipping a coin 16 times and it always

coming up heads. Some of these 16 measurements should have measured only the old material (30 AD) or only the new material (perhaps 1500 AD), yet no measurement gave these dates. Regarding the 700 AD date for the Sudarium for the invisible reweave hypothesis, a reweave of the Shroud would not have affected the carbon date for the Sudarium.

The neutron absorption hypothesis is the only hypothesis that is consistent with all four characteristics, i.e. the date, slope, and range of the dates for the Shroud and the 700 AD date for the Sudarium. To investigate the neutron absorption hypothesis, a nuclear analysis computer calculation was run using the MCNP (Monte Carlo N-Particle) software (Ref. 2). In this calculation, a human body was modeled in a linen cloth laying on the back bench in a limestone tomb. This model also included left and right benches in the tomb (Figures 1 to 7 in Ref. 2). This MCNP calculation is related to these four characteristics of carbon dating as follows:

- In the MCNP calculation, the number of neutrons required to be emitted from the body to produce a 1260 AD date at the 1988 sample location was 2×10^{18}. The MCNP results were normalized to this value. This means that the neutron absorption hypothesis being consistent with the 1260 date for the sample location is just the result of how the calculation had to be normalized.
- The slope of the carbon dates at the sample location that was experimentally determined by the three laboratories (36 to 38 years per cm) was found to be consistent with and thus apparently caused by the slope or gradient of the neutron density that naturally occurs at the sample location on the Shroud in a limestone tomb when the neutrons are emitted from within the body.
- The range of the measured values (1155 to 1376 AD) is consistent with the carbon dates calculated from the neutron distribution obtained in MCNP at the sample location (Tables 10 to 12 in Ref. 1).
- When working on the body on the back bench, a right-handed person would naturally drop the face cloth, after removal from the body, on the right-side bench about 12 to 15 inches in front of the back bench (Figure 1 in Ref. 2). The MCNP calculations determined that linen at this location would carbon date to about 700 AD, the same value obtained in the carbon dating of the Sudarium.

The shift in the carbon date for the Sudarium (30 to 700 AD) was calculated by MCNP to be smaller than the shift in the date for the Shroud (30 to 1260 AD) because the Sudarium was further from the source of the neutrons, which was the body. This agreement between the calculated value (700 AD) and the measured value (700 AD) for the Sudarium was discovered after the MCNP calculations were completed.

In general, after a hypothesis is developed that is consistent with all the characteristics of a phenomena, the hypothesis should then be used to make predictions that can be tested. If positive results are obtained in the tests, then the credibility of the hypothesis increases. If the results are negative, the hypothesis is falsified. For the neutron absorption hypothesis, the predictions are:

- There will be a distribution of carbon dates on the Shroud according to Figure 1 (from Ref. 3, also see Figures 11 to 14 of Ref. 2). This calculated distribution indicates that

most locations on the Shroud are predicted to carbon date to the future due to neutron absorption producing new C^{14} on the Shroud. The date shown in Figure 1 is the uncorrected date (not corrected for changing C^{14} concentration in the atmosphere) that would be obtained by using the same equations as are normally used to obtain a date to the past. This procedure was used to facilitate easy comparison to the 1260 AD date at the lower left corner, which is the 1988 sample location.

- Neutrons would have been absorbed in many different isotopes to varying degrees, producing new isotopes, some with long half-lives that might still be detectable on the Shroud or possibly the Sudarium.

An EXCEL spreadsheet was developed to perform calculations for the neutron absorption hypothesis. This spreadsheet was used to calculate the number of atoms produced in a 0.001 gram sample of Shroud linen by neutron absorption in 33 AD that would still be present, allowing for decay of the isotope from 33 AD to 2019. The results are shown in the right column of Table 1. The sample was assumed to be irradiated at the 1988 sample location on the Shroud, so that the neutron fluence (6.0×10^{13} neutrons per cm^2) calculated to be necessary to shift the carbon date from 33 AD to 1260 AD was assumed. The calculation also assumed trace elements (Ni-58 to U-238) to be present in their average abundance in the crust of the earth, which is a necessary assumption until measured values for trace elements can be obtained. A large number of atoms of other isotopes (H-2, B-11, K-40, and Re-107) not listed in Table 1 are also produced by neutron absorption but the number produced is insignificant compared to the number of atoms that would be naturally present, so that the number produced could not be measured.

Efforts are being made to determine how a test can be performed to determine whether the isotopes predicted in Table 1 are present. If this test gives statistically significant positive results, it would be evidence that the neutron absorption hypothesis is true, so that the cloth has experienced some type of nuclear event in which it absorbed neutrons. This would explain why a cloth that carbon dated to an apparent date of 1260 AD could have a true date of 33 AD. If this test gives statistically significant negative results, it would be evidence that the neutron absorption hypothesis is false.

References

1. Robert A. Rucker, "The Carbon Dating Problem for the Shroud of Turin, Part 2: Statistical Analysis", July 7, 2018. This is paper #12 at http://www.shroudresearch.net/research.html.
2. Robert A. Rucker, "The Carbon Dating Problem for the Shroud of Turin, Part 3: The Neutron Absorption Hypothesis", July 7, 2018. This is paper #13 on the above website.
3. Robert A. Rucker, "Proposal for C^{14} Dating of Charred Material Removed from the Shroud", October 15, 2015. This is paper #10 on the above website.

Biography

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

Table 1. Prediction of Atoms Produced by Neutron Absorption in a 0.001 gram Sample from the 1988 Sample Location

Parent Isotope that Absorbs the Neutrons	Isotope Produced by the Neutron Absorption	Decay Half-Life (years) for Isotope Produced	Number of Atoms Produced After Decay
N-14	C-14	5,730	2.49E+06
Cl-35	Cl-36	301,000	2.38E+06
Ca-40	Ca-41	103,000	71,000
Ca-44	Sc-45**	stable	3,020
Ni-58	Ni-59	76,000	6,230
U-235	Zr-93*	1,530,000	94
Nb-93	Nb-94	20,300	320
Th-232	U-233	159,200	418
U-235	U-236	23,400,00	11
U-238	Pu-239	24,100	39

* - Zr-93 is produced by fission of U-235.
** - Sc-45 produced by neutron absorption might not be detectable against the background of Sc-45 that might be naturally present.

Figure 1. Carbon Dates Predicted by the Neutron Absorption Hypothesis