Special Feature

Could carbon dating be erroneous if the Shroud was kept in a metallic container for a significant period between AD 30-2000?

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As commonly known, the Shroud was carbon dated by three independent laboratories and the results announced to the world in 1988. It was a shock to many that the date was scientifically measured at 1290-1360 AD. Furthermore, the three laboratories were in close agreement with each other. So confident were the three groups of scientists that they subsequently reported the Shroud to be a 'medieval artefact'. In their opinion, the Shroud had been fabricated by someone in the 14th century or thereabouts. Even the Vatican blinked at the seemingly awesome finality of these scientific results. Since then, the focus amongst scientists has not been if, but how the Shroud was fabricated. A casual observer now sees that the most populous topic of scientific research within the Shroud community is artistic techniques of the 14th century. Even so, there are those suggesting that the carbon-dating has been corrupted in some way, either by resurrection or fire (1532) in which the carbon 14 was replenished making the Shroud seem younger, or perhaps a bioplastic film accumulated on the Shroud, again altering the decay process enough to skew the results. By and large however, the 'artefact' camp has held sway and the world has watched as this much loved and treasured symbol of Jesus' resurrection has been pejoratively cast aside by the scientific world. Ordinary people including believers have no doubt been affected by these scientific findings.

However, as students around the world are taught, the scientific method is to validate one’s results. Scientists learn at first year undergraduate level never to presume results are correct until there is validating evidence. If a lawyer gains a conviction based upon a single piece of hard evidence, he will in all likelihood face appeal based upon that sole fact. If NASA were to launch rockets without failsafe systems to fall back on, the world might not have seen Neil Armstrong's first step upon the moon. So why did the three scientific groups decide in the case of the Shroud to claim the Shroud to be a fake? The three laboratories wasted hardly a day before coming to the dramatic conclusion that its scientific results could only point to a fabricated Shroud. No question in their mind, their results were infallible; after all, the three agreed very closely. Yet there is a host of evidence that suggests all is not well with a medieval date, including plant pollens found on the Shroud. These pollens indicate that the Shroud has been in the Western Mediterranean, either Anatolia or Israel, most probably Jerusalem, at some stage of its existence, yet it has not been in those regions in its known history since it turned up in Lirey in the year 1355 AD.

So the question needs to be asked then, if the carbon dating gives 1290-1360 AD, and the Shroud is genuinely from the time of Jesus, how can this be? Are these two facts incompatible and irreconcilable? Perhaps not. The early history of the Shroud is unclear. It isn't until the middle of the 14th century that we have solid evidence of its existence. Either by luck, good management, or divine intervention, the Shroud has been preserved from total destruction up until the present day. This has included two major fires that we know about, including one in our own time, and periods of warfare that have included pillaging and looting of major cities. As well as an object to be fought over by religious warriors of various faiths, and an object to destroy for whatever misguided reason by fire (1997), the ravages of time have also been quietly taking their toll on the Shroud and its image. When we consider the fact that the Shroud has survived till the present day, this is miraculous in itself. How many pieces of linen, intrinsically a very flimsy and fragile substance, have survived from antiquity including the Middle Ages? In the following we examine how the containers that held the Shroud may have played a role in its preservation not only from human intrigues surrounding it, but also from the ubiquitous threat of chemical and isotopic decay.

What do we know about any containers that have held the Shroud? Ian Wilson, author of *The Blood and the Shroud*, answered: "From sometime in the 1st century to AD 525 it was hermetically sealed in a stone or brick vault, but probably not inside a metal container. From AD 525 onwards till the present time it was almost certainly always kept inside some metal casing, though not necessarily as its primary container. The chests themselves did not necessarily have locks, though whatever chamber they were in, certainly did. For instance, when at Chambery it was behind a locked grille, hence the difficulty rescuing it from the fire. When at Lirey it was inside a locked Treasury section of the church, and so secure, a posse of royal officials were unable to gain entry. We do not know whether these ancient containers were airtight, though if you examine ancient chests, they are usually efficiently sealed." The containers were of various sizes due mainly to the method of folding. Sometimes folding was governed by the desire of the owner of the day to conceal it in small crevices from opponents. The absolute need to safeguard it from harm continues to our present time. After public viewing and veneration was finished, any lid would have always been replaced over the rest of the reliquary and the Shroud once again sealed inside its airtight container.

What would an airtight metallic container such as the one suggested above do to the process of carbon 14 decay? Well in short, we don't know, either way. But it may well be that the process of carbon 14 decay can be brought to a halt inside the container if the reaction is enclosed and the electrons given off by the β–decay process are not allowed to escape, as they would do if there were no metal container. The process of halting the decay process might be relatively fast, or it might take some years to accomplish. As stated, the Shroud may well have been housed inside various metal containers from AD 525-2000. It might have been some time between viewings, each time being returned to its container. Its time prior to AD 525 would probably not have interfered with the carbon 14 process. Since then, it may be that some of this time has not been recorded by carbon-dating methods, depending on how long it takes to shut the process down. To get the date AD 1290-1360, the actual time spent inside the metal container, 1463 years, must be shortened to about 800 years, in other words measured time must be reduced to 54.7% of elapsed time.

How could the carbon 14 decay process be brought to a halt? We need to do some estimating to first work out how much carbon is involved. We do know that the Shroud is 1.09 m (3 ft 7 ins) wide and 4.34 m (14 ft 3 ins) long. Its total mass is not in the literature but can be estimated at about 500 gms. Neither is the Shroud's chemical composition found in the literature. An estimate of around 10% total carbon should be reasonable. So, we have about 50 gms biological carbon. This total carbon is divided into 98.89% carbon 12, the normal form, 1.11-% carbon 13 the lighter radio isotope, and finally 1 atom in 1012 is carbon 14. We thus estimate that there are about 2.5 x 1012 atoms of carbon 14 in the Shroud, and their decay will produce an initial rate of around 750 counts per minute, with a half-life of 5,730 yrs. Initially after biological death, this means that around three carbon 14 atoms in 109 will decay each minute. The count will be given by the decay formula:

Eqn (1)

$Dt = t_1 \ln(1 + \frac{N_D(t_1)}{N_P(t_1)})$ where Dt = 630-700 yrs (approx) l = 5,730 yrs t_1 = present time.

The decay is a β–decay process (beta-minus-decay) where a neutron converts into a proton plus an emitted electron. Thus radioactive C14 converts to stable N14.

$$n \rightarrow p + e_{-} \qquad \text{Eqn (2)}$$

$$^{14}_{6}C_{8} \rightarrow ^{14}_{7}N_{7} + e_{-} \qquad \text{Eqn (3)}$$

(there is also an electrically neutral intermediate product called a neutrino).

According to Krane, β–decay is a weak effect involving transition from one nuclear quasistationary state to a second, similar to an atom changing states and emitting light. The probability of transition is usually very unlikely, hence the long half-lives. The weakness of the effect is illustrated by the magnitude of half-lives associated with β–decay that are much longer than the characteristic times (10-20 secs) associated with normal 'strong' nuclear reactions. The longer the half-life the weaker is the interaction. Fermi's theory of β–decay was developed in 1934. In his honour, the equation relating to decay rate includes a constant termed the Fermi integral. This equation involves a number of fundamental constants, eg. Plank's constant and the speed of light. Assuming the mass for a nucleon (neutron or proton), Krane compared β–decay with other nucleon-nucleon interactions:

Pion-nucleon ("strong")	1
Electromagnetic	0.01
B–decay ("weak")	0.00001
Gravitational	0.0000000000 0000000000 00000000000 00000001

In Krane's words "....Progress in understanding β–decay has been achieved at an extremely slow pace, and often the experimental results have created new puzzles that challenge existing theories". While β–decay theory is complicated and mathematically intricate, we can get some idea of what might happen to the Shroud inside a metal container. Electrons resulting from Eqn 2 undergo many collisions bouncing off molecules within the Shroud, and the inside walls of the container. They emit radiation due to collisional changes in acceleration (known as Bremsstrahlung, German for 'braking radiation'). As this occurs, they slow up and any radiated energy causes increased thermal energy inside the container. While the electrons lose energy, they must by charge conservation remain either unchanged as charged entities, or be converted into a negative molecular entity. Entrapped, there will be a build-up of these electrons as the decay process proceeds in time. The build-up may induce (a) the electrons to remain 'free' wandering and colliding inside the space inside the container surrounding the Shroud, (b) the electrons to recombine with atoms or molecules within the Shroud. Whatever happens, there is a separation of negative and positive charge as electrons ejected from the neutrons leave behind positively charged protons. This separation is a potential energy, which the closed system will minimize by collocating charges as close together as it can. A balance exists between the container's internal heat, and the potential and kinetic energies of all internal matter. Hence we see that the volumetric size of the container's interior is a factor.

Where these electrons eventually reside is most important as to the probability that they can effect the β–decay process. Carbon plays a central biological role forming covalent bonds with other carbon atoms eg in similarly aligned long-chained hydrocarbons or ring-shaped glucose. Geometric centrality means that changes to one carbon atom can affect a number of neighbouring carbon atoms If there is a deposit of electrons within the fabric of the Shroud this will result in relatively high Coulomb fields compared with the same electrons remaining uncombined somewhere else inside the container, eg near the metallic surface. Any effect of the entrapped electrons is also seen by comparison with the case if the Shroud were kept in open air. Unhindered, the electrons rapidly move away from the Shroud due to their energy. In metal, as the build up proceeds, freshly ejected electrons resulting from Eqn 2 are opposed by any effects of previously ejected electrons. If there were no container, after the ejected electrons have scattered away, some other molecular species eg an oxide, or bacteria might attach itself to the Shroud at the positively charged proton sites. Such molecular bonds are relatively larger and weaker than tiny electrons that can be attached as valance electrons within the biological carbon structures of the Shroud. The potential due to such electrons is larger and more central than that of molecular bonds. These electrons are a small perturbation to the slow decay from the quasi-stationary state that is radioactive C14 to the stable state that is N14.

Overall, the decay process may be brought to a complete standstill until such time as the lid is opened. When this happens, the N14 may ionize with the escape of the valence electron thus initiating the C14 decay process once again until next time the lid is closed, and the build-up restarts. It is estimated that the build-up after the first year of entrapment is about 3.9 x 108 elementary charges. This represents about 1/6,000 part of the total charge due to the carbon 14 atoms. C14 decay with its half-life of 5,730 years is intrinsically relatively weak in the wide range of nuclear reactions. It takes a long time for the count to drop by 50%. A seemingly small change in the surroundings may produce a distinct effect upon the rate and character of the reaction. We could keep going with the computations and calculate the Coulomb fields inside the Shroud fibres. At the end of the day, we can only hypothesise about what will happen. What we need to do is to perform an experiment using linen enclosed in a metal container, and see what happens as the counter is left running inside the container. If we hear a diminution of the rate at which electrons are counted, remembering that the trapped electrons may now confuse the count somewhat by bouncing around off the walls of the container, we should be able to find out if the decay process is slowing down. But that's another chapter in the intriguing story of the Shroud.

As an addendum to this hypothesis, the reader might be interested to know that on those occasions when metal containers have been found, the biological contents are generally well preserved as in the following extract from Ian Wilson's book The Blood and the Shroud, p.57-58: "During summertime excavations at St. Bee's Priory in Cumbria, Dr Deirdre O'Sullivan and her archaeological team came across a lead coffin that from the Priory's known history they gauged must date to around 1300 AD.....When they opened it up, to their astonishment, inside was not the rubble of skeletal remains that they expected, but instead the fully intact and enshrouded body of a partially bearded, bald-headed man who, from his injuries, had seemingly died either in battle, or during jousting....he was so well preserved that his flesh was even still pink and supple...".

Some type of protection from chemical decay appears to be present in such cases. Whether this protection includes radio isotope reactions remains to be seen. Thus far in its history, the Shroud has been preserved for all to see and, if they are believers, for some to venerate. As far as we know, and not including divine intervention, we are somewhat fortunate to still have the Shroud with us. If the hypothesis is valid, then preservation of the Shroud and other perishable fabrics from antiquity eg the Dead Sea Scrolls might best be preserved inside close-fitting metallic-glass composite enclosures. Such housings may turn out to be the best protection against decay from chemical erosion from without such as bacteria, and erosion from within such as carbon 14 decay. In this way, we in our time might help insure that people of future ages will be able to venerate the physical reality of the Shroud, and the Shroud might best be protected from the ravages of time.

As a reference, I used Ian Wilson's book *The Blood and the Shroud*, Weidenfeld & Nicolson, 1998. I would also like to acknowledge Ian's kind assistance with the historical details concerning the various metallic containers that have been used to house and protect the

Shroud. A primary text on nuclear processes is K.S. Krane, Introductory Nuclear Physics, Wiley, 1988.

On May 16 Dr. Alan Adler, invited to comment on Dr. Fleming's hypothesis, responded as follows:

> Thank you for your hypothesis to explain the radiodating anomaly. Every atom is surrounded by a 'cloud' of electrons that coulombically are much, much closer to a nucleus than electrostatic charges on an enclosing container would be. Therefore, if your hypothesis were correct, we would never see electron emission (beta decay) from any nuclei at all. To make your idea work you would have to invoke some new type of force field not governed by Maxwell's equations. I can see how such an electrostatic field might retard bacterial decay, but not nuclear decay. Sorry.
> Sincerely yours, Alan D. Adler

Tony Fleming has replied to Alan Adler's criticism as follows:

An important question is where ultimately the entrapped electrons will reside. They may want to seek out the sites of the positively charged protons from where they were generated. Hence they may end up being distributed randomly throughout the molecules that comprise the Shroud. The location of free charges inside a metallic container is tricky. When the box is empty of charge, the potential at the conductor surface will by Gauss' law be zero. As electrons are ejected from the C14 nuclei, we can use the method of images to determine that some charge perhaps might sit on the conductor surface, at least for a brief period of time. The situation is complex because reactions occurring inside the Shroud produce an unstable charge distribution in which the particles move. The fast electrons disturb those electrons which have already lost their kinetic energy and are reasonably stationary. If the potential at the conductor surface increases during this period, then freshly ejected electrons will tend to shy away from the conductor surface. While similar to electrostatics, the difference is the continuing motion of the fast electrons and the fact that the ejected electrons do not have sufficient energy to return all the way back to the nuclear sites where they were generated.

Entrapment within the container demands that free electrons settle somewhere in the container. Given the need to minimize potential energy, where better than somewhere near one of their original partners the positively charged protons. They may not be energetic enough to get back inside the nucleus of one of the stable N14 atoms, but they may be able to reside in an allowed atomic state of one of the N14 atoms. Due to their more compact orbital we may well find that these electrons have relatively more influence over neighbouring carbon atoms than molecular structures of like valance.

Dr Tony Fleming's areas of expertise are bioelectromagnetics, theoretical and numerical electromagnetics and antenna analysis. He has investigated the effects of RF on the unborn foetus and embryo, metallic implants within the human body and numerical methods for analyzing ionic currents within cellular structures. Currently completing his studies at Monash University, Australia, he has worked with the Australian Department of Defence, and at the Telstra Research Laboratories.