SPECIAL FEATURE:

THREE THEORIES OF HOW THE RADIOCARBON AGE OF THE SHROUD MAY HAVE BECOME `YOUNGER' THAN ITS TRUE AGE

Theory no. 1: Harwell scientist Dr. Kitty Little:

"Nuclear disintegration would seem to be the only feasible way of producing the image ... The extra carbon-14 would tend to make the apparent age of the fabric appear to be more recent than it really is"

Former Atomic Energy Research Establishment Harwell scientist Dr. Kitty Little, M.A., B.Sc., D.Ph. (Oxon), writing in her recent article 'The Holy Shroud and the Miracle of the Resurrection', *Christian Order*, April 1994, pp.225-227, from which the following is an extract:

The facts [of the Shroud] that have to be accounted for are that the image was formed from inside, by something emanating from the body, with a range, of four centimetres, and that it changed the colour of cellulose fibres in the linen cloth to a straw yellow, while making these more friable. Until now this has been regarded as an insoluble problem, but I do not think that it is.

Some scientists have suggested something in the way of a nuclear disintegration, acting almost instantaneously, as with the flash from a nuclear explosion. Others have discounted this explanation because they thought that too much energy would be released - that it would be the type of explosion that would destroy everything in the vicinity. However, if a human body were to disintegrate, the amount of energy released from that stored in the nuclei of the component atoms should be considerably less. The main elements present in the body are hydrogen, carbon, oxygen and nitrogen. All these are light elements, with much smaller nuclei, and less stored energy than in the very heavy elements that are used to make nuclear weapons.

The main building blocks of the nuclei of atoms are protons, alpha particles (helium nuclei containing two protons and two neutrons closely bound together) and neutrons. The hydrogen atom's nucleus consists of a single proton. When disintegration takes place, not only does the nucleus split into those main components, but these in turn can split to produce mesons and other small particles. Gamma radiation is emitted and energy released.

Range of Shroud image

In the case of the Shroud the distance of the cause of the image from the cloth, as shown in the experiments of Jackson and his colleagues, was up to four centimetres. That is the range of alpha particles, mesons and some of the other particles in the air. Their range in solid matter is very limited. This could account for the small penetration in the fibres of the Shroud, together with the fact that the blood already present was able to protect the underlying material from change. Nuclear disintegration would seem to be the only feasible way of producing the image.

Mechanism

There remains for consideration the mechanism whereby the changes were produced in the linen cloth. In 1950 I irradiated a range of fibres and plastics, including several different cellulose fibres, in BEPO, a research reactor at the Atomic Energy Research Establishment at Harwell. At the time BEPO was being run at only 3MW, so that the temperatures were in the range 70°C to 90°C. This meant that I was obtaining radiation effects without the complication of heat effects. Cellulose fibres turned to the straw-yellow colour that has been described for the image of the Shroud They became friable, and there were changes in their internal structure that could be detected by means of X-ray diffraction.

In those experiments samples were irradiated in the presence and in the absence of air, over a period of time. Oxidation affected the results. The description of the image on the Shroud would seem to correspond with the results obtained from my experiments when using a more prolonged irradiation in the absence of air. This would be consistent with the formation of the image being almost instantaneous, when there would not be time for oxidation reactions to take place.

The gamma radiation which must have been emitted would also affect the linen cloth. Its range would include the whole of the cloth. The effects of radiation on cellulose fibres vary considerably according to the molecular structure of the fibre [Dr. Kitty Little, chapter on the effects of Ionising Radiations on Polymeric Materials in *Photographic Techniques in Scientific Research*, Academic Press, 1978, vol. 3]. With poor quality material one would expect degradation at comparatively low doses. With good quality material, although higher doses degrade it, lower doses act to enhance its stability and resistance to degradation - and it has been reported that the linen of the Shroud is in very good condition. This would be in accord with the rich Joseph of Arimathea buying the best available.

That much can be said with a reasonable degree of confidence. The particles would also be accompanied by neutron emission, but it is impossible to say at what intensity. There are several ways in which atomic disintegration could occur, and there is not sufficient data available to attempt to calculate the possibilities. The action of neutrons would result in the formation of extra carbon-14 in the linen sheet - the whole of it, and not just in the area of the image. The extra carbon-14 would tend to make the apparent age of the fabric appear to be more recent than it really is, but there would be no means of ascertaining the extent of the discrepancy. It could well be within the limits of experimental error.

Energy

One would not expect the amount of energy released to cause a violent explosion, but it would certainly make itself felt, and according to Matthew 28:2 the moment of the Resurrection was accompanied by a 'great earthquake' ... [that was apparently] sufficient to displace the heavy stone at the mouth of the tomb and to terrify the guards, but not to cause serious structural damage to the rock from which the tomb had been hewn. It seems to have been localised, and centred on the tomb, which would fit in with the cause being the energy released as the nuclei of the atoms in the body disintegrated. There is, of course, no natural way in which the nuclei of light elements could disintegrate in this manner. Such a happening would be strictly miraculous.'

Theory No. 2 Moscow nuclear scientist Dr. Dmitri Kouznetsov:

"Carbonization of the textile cellulose leads to a significant error in the radiocarbon dating results"

Lenin prize-winning scientist Dr. Dmitri Kouznetsov, Director of the E.A. Sedov Biopolymer Research Laboratories, Moscow, has prepared a very full scientific paper "Chambéry Fire of 1532 as the Unique Event in the 'Chemical History' of the Shroud of Turin" .which it is hoped will be published in a major U.S. scientific journal in the near future. Kouznetsov's summary and précis of the experimental methods he and his colleagues used was reproduced in the *Lettre Mensuelle du CIELT* no. 54, as follows:

Summary

A laboratory model especially created to replicate the physical/chemical conditions of the 1532 Chambery fire has been used with an aim to evaluate experimentally a probability of the fire-induced chemical modification of the Turin Shroud textile cellulose and its possible impact on the radiocarbon dating results. In these studies, both modern and old Palestinian (En Gedi site, Israel, BC100-AD100) linen textile samples were tested by near-1R reflectance spectro-photometry, field ionization/field desorption mass spectrometry, and conventional AMS analysis.

It has been found that the different fire-imitation model conditions are able to promote carboxylation of the unscreened OH-groups in the textile cellulose molecules This carboxylation process involves the carbon-containing combustion gases, CO and CO_2, in the presence of silver cations [positively charged ions], water and heat. As a result, a significant additional amount of carbon 14 and carbon 13 atoms become incorporated into the textile cellulose structure as a part of carboxy groups.

The radiocarbon ages of experimental textile samples incubated at the fire-imitating conditions have been calculated by a common AMS technique with a following correction for C-isotopes fractionation. As seen from the obtained data, the fire-induced carboxylation [i.e. carbonization] of the textile cellulose leads to a significant error in the radiocarbon dating results. The extent and the mechanism of this phenomenon as well as the problem of accuracy and the limitations of the radiocarbon method are under discussion. All experimental data and theoretical statements presented in this work deal with the re-evaluation of the Shroud of Turin dating results as obtained by Damon et al. (1989), using a conventional radiocarbon dating approach.

Experimental: Materials and Reagents

Employed in these studies was a non-dyed textile manufactured in 1993 by the Krasnodar textile factory using flax of the long-fibred *Linumusitatissimum* cultivated in southern Russia.

Another linen sample, the textile sample from En Gedi, Israel, was supplied by courtesy of the Israel Antiquities Department through the good services of Prof. Mario Moroni, Robbiate, Italy. This burial linen cloth excavated at the En Gedi site by G. Hadas et al. has been dated at the University of Arizona's AMS laboratory at Tucson, Arizona, using a conventional radiocarbon

technique. By radiocarbon dating the age of this textile has been calculated as between 100BC and 100AD, i.e. the early Roman period.

Thermal/Gas Treatment of the Textile (fire imitating model)

The textile samples were incubated for ninety minutes at more than 200 degrees centigrade in an artificial atmosphere containing CO_2 (0.03%), CO (60μ/m3) and demineralised H_2O (20g/m3). In this procedure the vaporised demineralised water had been previously treated with silver metal (40g/L for 10 days). The resulting concentration of silver cations in this water used for the thermal/gas incubation procedure was 0.80 - 1.45 μ/L. For all these incubation experiments a Medicel-RX 200 Thermogas Laboratory Unit (Medteknica, Russia) was employed. Silver cation concentrations were determined and monitored with an AAA300 Atomic Absorption Spectrophotometer (Karl Zeiss, Jena, Germany). The results of our AMS measurements and their dating interpretation are presented in figures 9 and 10 [for publication in Dr. Kouznetsov's scientific paper - Ed.]

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[*Note: the above has been very slightly edited for the purposes of improving the English translation.*]

<u>Theory no. 3: French scientist Dr. Jean-Baptiste Rinaudo</u>:

"a piece of linen can be enriched with radiocarbon by neutron flux, in a manner to create inaccurate carbon dating calculations"

Dr. Jean-Baptiste Rinaudo (seen right), Doctor of Science of the Centre de Recherches Nucléaires Médicales, writing on his experiments thermally irradiating a piece of ancient linen with neutrons, in the *Lettre Mensuelle du CIELT*, no. 54, June 1994. This article has been translated by the Editor from the French (subject to some of the difficulties of the scientific terminology) as follows:

Introduction

In the same issue of the journal *Nature* which carried the results of the Shroud carbon dating [1] American researcher Thomas J. Phillips pointed out that if the formation of the Shroud's image

had been due to some form of neutron irradiation, then its carbon 14 content would have been enriched. He envisaged for this the nuclear reaction:

(1) $C13 + n \rightarrow C14 + E$ (8 MeV) sect. eff. = 0.9 millibarn

and he calculated that a flux of 2.10^{16} n/cm= would produce an enrichment of radiocarbon making it appear some thirteen centuries younger than reality.

Dr. Robert Hedges of the Oxford carbon dating team objected that the flux envisaged by Phillips was 1000 times too strong, for he had a piece of linen with nitrogen estimated at 1000 parts per million. The reaction was then:

(2) $N14 + p \rightarrow C14 + p$ sect. eff. = 1.75 barn

This reaction, having a much greater yield, the flux proposed by Phillips would date the Shroud sample into the future. Hedges estimated that the true flux necessary to give a 13th century dating error would be only 2.10^{13} n/cm^2.

This then is what CIELT's Scientific Council, in its *Lettre Mensuelle* no. 27 (March 1992) wrote on the subject: 'It seems impossible to accept an enrichment of the Shroud's linen along the lines of the quoted reaction because the carbon 14 produced would not stay in the molecular chain. Once formed, it would be transformed into carbon gas on contact with the air. It seems then that only the reaction (1) would be capable of enriching the linen with carbon 14 by transforming a certain number of carbon 13 atoms in the cellulose to carbon 14.'

Because no experiment had been done to address this problem, we thought we would arrange one ourselves. Following the remarks of the CIELT Scientific Council we opted for irradiation with the neutron flux calculated by Phillips, i.e. 2.10^{16} n/cm^2. The results we obtained show that Hedges was right.

Material and methods

We used a fragment of ancient linen that belonged to an Egyptian mummy dated 3,400 BC. Its radiocarbon date was measured by the University of Toronto's Isotrace Radiocarbon Laboratory as 4,670 years ± 60 years BP (before the present). The irradiation with thermal neutrons was carried out at Saclay (CEA) in their 'Orphée' reactor. The exposure time was 20 minutes. An instrument inside the container enabled precise measurement of the actual global flux. This was 1.7 n/cm^2 ± 10%. The irradiated sample displayed a low β activity. It was then sent to Toronto for radiocarbon dating by the AMS method and for what would now be a new date.

Results and Discussion

The irradiated fragment had been enriched with radiocarbon by comparison to its former state by a factor of 570 x. Its carbon 14 content was 31,900 % pMC (% of modern carbon), that is to say 319 times the normal level. It was as if its age was 46,000 years into the future! The

'rejuvenation' obtained was more than five hundred centuries. This calculations used a $\delta\ ^{13}C = -25‰$.

At the end of this finding, we could calculate with precision the global flux of thermal neutrons necessary to produce a C14 enrichment which would produce a dating error of thirteen centuries. George Salet [2] had evaluated this at 17% above normal. A simple calculation gives us then the value of this flux as $1{,}7\ 10^{16}$ x 0,17/ 319 + $9\ 10^{12}$ n/cm^2. (this corresponds to a time of 0.64 seconds in the reactor). The value of the flux proposed by Hedges was not very far out from this value.

What then happened, that the backward energy from the reaction should have absorbed the carbon 14 formed by the molecule? Very definitely an important reintroduction of the radiocarbon into the cellulose fibres by isotopic exchange.

Conclusion

The results obtained show that a piece of linen can be enriched with radiocarbon by neutron flux, in a manner to falsify carbon dating calculations. Looking at it another way, the value of the flux necessary to make a thirteen century 'rejuvenation' accords with the 'deutonic' model which we [i.e. J.B. Rinaudo, ed.] presented to show could account for the formation of the image and for the dating error [4, 5]

So, just as predicted by Thomas J. Phillips [1], all happened as if the image forming mechanism, by radiocarbon enrichment, had made the Turin Shroud appear thirteen centuries younger than actuality. Furthermore, the scatter of the results obtained since the dating (carrying an abnormal value of Ki2 [6], despite the elimination of eight aberrant points [7]), is in accord with the predictions of the same model.

The Turin Shroud should then date to the first century, and by the accumulation of all the details that it contains on the Passion, on the death of Jesus and on his time in the tomb, should be regarded as genuinely that of Jesus of Nazareth

Acknowledgements

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[† Editor's note: sense unclear - my rendering from the French 'il y avait dans un tissu de lin de l'Azote estimé à 1000 ppm' may be less than perfect]

References

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