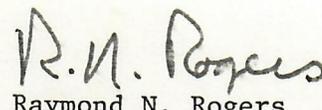


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RADIOCARBON DATING OF THE HOLY SHROUD OF TURIN

[Report of the C-14 Dating Committee of the Shroud  
of Turin Research Project (STURP)]

  
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ABSTRACT

C-14 dating techniques currently use very small amounts of material and produce dates reliable to within about a century. This situation appears to make the application of the accelerator and proportional counter methods to dating the Shroud of Turin very attractive.

This report recommends that the radiocarbon dating tests be done as soon as possible and confirmed within the next 2 years. In addition, 3 nondating tests also should be done in order to maximize the amount of information obtained from the small amount of cloth available.

## I. INTRODUCTION

Neutrons produced by cosmic rays in the earth's atmosphere interact with nitrogen atoms and form a heavy isotope of ordinary carbon ( ${}^{14}_6\text{C}$  or C-14) according to the reaction  ${}^{14}_7\text{N} + {}^1_0\text{n} \rightarrow {}^{14}_6\text{C} + {}^1_1\text{H}$ . (1) The C-14 produced eventually becomes incorporated into the carbon dioxide of the atmosphere to the extent of a C-14/C-12 atomic ratio of about  $10^{-12}$ . There is an equilibrium of carbon dioxide in plants with that free in the atmosphere. Plant-eating animals including human beings also become a part of this balance.

When plant or animal life ceases the organism is removed from the equilibrium. Subsequent radioactive decay of C-14 back to nitrogen according to the equation  ${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + {}^0_{-1}\text{e}$  (2) changes the C-14/C-12 ratio. It takes about 5700 years for this carbon quotient to decrease by a factor of 2.

Over 30 years ago W.F. Libby showed that by measuring the amount of C-14 present in a "dead" sample and comparing it to that present in a "living" sample, the time of "death" - i.e. removal from the steady-state equilibrium set up with the atmosphere - could be ascertained. Ages accurate to within one or two hundred years for objects which are between several hundred and several tens of thousands of years appear achievable. Radiocarbon dating of much younger or older objects frequently runs into problems due to either the very small change in or the vanishingly small amount of C-14 present. Within limits, however, C-14 "dates" agree quite well with those determined by other methods.

## II. APPLICATION TO THE SHROUD OF TURIN

The possibility of using C-14 dating methods to estimate the age of the Holy Shroud has been recognized for sometime. The main deterrent seems to have been the relatively large amount of cloth that would be destroyed in obtaining a meaningful date. For example, an average age with estimated standard deviation would require several square feet of the linen.

Significant advances, however, have been made in C-14 dating techniques during the past several years. New equipment and techniques have improved greatly counting accuracy and statistics. Furthermore, particle accelerators have been adapted to function as mass spectrometers and measure actual amounts of the isotopes of carbon present in a given sample. Equally important is the dramatic decrease in the size of the sample. The amount of carbon now required is down into the impressive milligram range. Measurement times remain at several months with decay-counting methods but are only days using accelerator techniques.

## III. PROPOSALS FOR DATING THE SHROUD

Ten recognized experts in the field of C-14 dating were asked by our committee to submit proposals for dating the Turin Shroud. Five replied.

Drs. Harry Gove of the University of Rochester and Garman Harbottle of Brookhaven National Laboratory answered as a single proposal involving the use of both the accelerator and counting methods. The requested quantity of cloth is 55 mg. Two ages would be obtained, one from each method. These experimenters expect "a date accuracy of  $\pm 150$  years or better." They are ready to start now and estimate a total time of several months after receipt of material for a Shroud "date."

Dr. Edward Hall of Oxford University said he would not be ready before the latter part of 1982. His method is the accelerator/spectrometer technique and will be scrupulously free from contamination. He will require 25 mg of sample (not identified as "carbon" or "cloth") and quotes "a precision of  $\pm 50$  years at 2 standard deviations."

Dr. Stuart Fleming, Director of the Museum/Applied Science Center for Archaeology of the University of Pennsylvania, declined "to become involved in any radiocarbon determination."

Dr. J.C.D. Milton of the Nuclear Physics Branch of the Chalk River Nuclear Laboratories in Canada is not ready yet. CRNL employs the tandem accelerator as a mass analyzer for C-14 and currently uses about 25 mg of the element. We estimate he would need a piece of the Shroud weighing 60 mg. Our Shroud area-density value of  $1.36 \times 10^{-2} \text{g/cm}^2$  indicates  $4 \text{ cm}^2$  of the relic would be required.

Drs. Richard Muller (University of California at Berkeley, USA), Hans Oeschger (University of Bern, Switzerland), Erle Nelson (Simon Fraser University, Canada), Fred Schmidt (University of Washington, Seattle, USA), and Paul Damon (University of Arizona, Tucson, USA) have not responded to date.

#### IV. ADVISORS IN PROPOSAL EVALUATIONS

Drs. Minze Stuiver (University of Washington), Rainer Berger (University of California, Los Angeles), and Walter Sondheim (Los Alamos Scientific Laboratory, formerly associated with Dr. Gove at University of Rochester) act as advisors to the STURP C-14 Dating Committee.

## V. RECOMMENDATIONS

This committee is not certain exactly how much of the material removed from the Shroud in past years is still available. We will assume that the samples removed in 1973 could be obtained for testing. For convenience we use the listing given in Ian Wilson's book The Turin Shroud in this report (Appendix A) for reference.

We strongly recommend that C-14 dating be done as soon as possible. From a scientific standpoint it is one of the few tests remaining. From a popular viewpoint it is "the" test. All other data - no matter how convincing to research and knowledgeable persons - are peripheral in the mind of the average person. There is thus much to be gained by releasing material for "dating" tests as soon as possible - scientific data, popular appeal, and realized credibility.

The C-14 Dating Committee has considered the question of radiocarbon measurements on The Shroud from many viewpoints. While urgency motivates us to choose one proposal now, scientific responsibility forces us to look to the immediate future for possible better methods of age-determination. Both these responsibilities can be discharged by recommending that

- 1.) the Gove/Harbottle experiments (Appendix B) be supported now and
- 2.) the Hall (and/or others) proposal be implemented when the equipment becomes operational and proven. Drs. Gove/Harbottle are eminent scientists with proven reputations in their fields. While their work may be improved upon in the foreseeable future, it is of such high caliber that it almost certainly will not be contradicted. In short, we feel a date for The Shroud of Turin should be obtained by Gove/Harbottle within the next several months and confirmed by another independent researcher within

the next several years. Science is fortunate to have these tools available now at the same time as it sees more precise ones being forged.

This committee also urges that 3 additional tests be allowed on Shroud samples. The first 2 are X-ray diffraction and confirmation of the 1973 Raes' textile characteristics. All possible information should be gathered and important data rechecked before the material is irretrievably reduced to carbon for the date-test. The 3rd test is "blood" and image identification work. Past work must be confirmed and expanded if possible. There is no need for the threads from the "blood" and image areas to be destroyed. They will not; they will be returned.

For the purposes outlined above, this committee requests that the following samples of the Holy Shroud of Turin be transferred to the coordinators of The Shroud of Turin Research Project, (STURP), Inc. - Drs. John Jackson and Eric Jumper - to be used as indicated below.

1. The 40 mm x 13 mm sample cut from bottom right-hand edge (piece I of Raes' report). Item 3, Appendix A, this report. Approximately 70 mg of material, the sample will be given to Drs. Gove/Harbottle, for C-14 testing after nondestructive examination by Raymond Rogers, STURP.
2. The 40 mm x 10 mm sample cut from the side strip (piece II of Raes' report). Item 4, Appendix A, this report. For nondestructive examination by Raymond Rogers only.
3. Items 9, 10 or 11, 15, 16 or 17 for nondestructive X-ray diffraction and "blood"/image studies. Raymond Rogers and Robert Dinegar, directive investigators. Other specialties involved if necessary.

NB. Item 3 will be destroyed, reduced to carbon for C-14 dating tests. Some of the carbon will be permanently retained in the form of the gas, carbon dioxide (See Gove/Harbottle proposal).

Items 4, 9, 10/11, 15, 16/17 will be returned as requested.  
Nondestructive tests only.

It is of the utmost importance that information as to exactly where on The Shroud each sample came from be forwarded with the material.

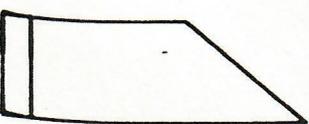
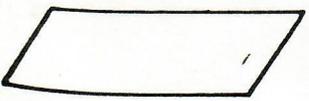
In view of the above-average public interest in C-14 dating, we recommend publicity initiatives and news releases as the tests are implemented. Specifically, we suggest as fitting 1.) an announcement from the appropriate office in Turin concerning the transfer of the material for the tests with 2.) a follow-up news release from STURP/Gove that the C-14 experiments are underway.

Dr. Gove has agreed in writing that no Shroud "date" will be publicly released until 1.) the results of both methods are completed and 2.) the office of the Archbishop of Turin has been notified in writing. Everyone appreciates that His Eminence should know the outcome of the research well in advance of the general public. Finally, representatives from STURP and the Archbishop are invited to be present during the actual experiments of the C-14 testing. We have accepted the invitation and hope someone from Turin also will be there.

Taken from: "The Turin Shroud" by Ian Wilson  
London, Victor Gollancz, Ltd 1978 pp251/252

APPENDIX A  
SAMPLES TAKEN FROM THE TURIN SHROUD  
NOVEMBER 24, 1973

FOR PROFESSOR G. RAES

Item No.	DESCRIPTION	CHARACTER
1.	 One 12mm. weft thread from bottom right-hand edge	No image
2.	 One 13mm. warp thread from bottom right-hand edge	No image
3.	 One 40 mm. x 13mm. sample cut from bottom right-hand edge (piece I of Raes's report)	No image
4.	 One approximately 40mm. x 10mm. sample cut from the side strip (piece II of Raes's report)	No image

FOR PROFESSORS MARI and RIZZATTI  
(representing PROFESSOR FRACHE)

5.	 One 28mm. thread from bottom right-hand edge	No image
6.	 One 8mm. thread corresponding to bloodstain seeming to be from scourging	Scourge mark
7.	 One 4mm. thread and 6.5mm. thread, being originally joined, from apparent scourge mark above (Reddish tint of blood observed on snapping to be only on surface of thread; interior perfectly white)	Scourge mark
8.	 One 19.5mm. thread from area of blood flows across small of back	Flow across small of back, dorsal image
9.	 Two 12mm. threads from bloodstain that appears to have trickled from foot onto cloth	Flow from foot, dorsal image
10.		Flow from foot, dorsal image
11.		
12.	 One 17mm. thread from same	Flow from foot, dorsal image
13.		Flow from foot, dorsal image
14.		
15.	 One 13 mm. thread from image of bloodstained right foot	Bloodstain of right foot, dorsal image

FOR PROFESSORS FILOGAMO and ZINA

16.	 One 13mm. thread from image of bloodstained right foot (taken parallel to above)	Bloodstain of right foot, dorsal image
17.	 One 18.5mm. thread from same	Bloodstain of right foot, dorsal image

KEY:  
 samples seeming to bear image  
 samples without image