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Radiocarbon Ages of a Possible Titian Painting

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Abstract: A radiocarbon study of a painting that might have been made by Titian or Tintoretto or by their workshops is presented. It could be the lost Titian self-portrait or, more convincingly, the sitter might be the Venetian Andrea Cappello, elected *Procuratore de Supra* in 1537 AD. Due to the variability in the concentration of atmospheric radiocarbon during the reference period, the calibrated ^{14}C ages of the painted canvas are 1450–1530 and 1540–1635 AD (2 σ), while those of the wooden frame are 1504–1597 and 1616–1657 AD (2 σ). They are also consistent with previous analyses based on scanning macro X-ray fluorescence. These results, combined with stylistic, considerations suggest that the painting was made in the first half of the 16th century by Titian or his workshop. Circumstantial evidence that the painting was executed between 1523 and 1528 is also discussed.

Keywords: radiocarbon dating; Titian; Jacopo Tintoretto; Jacopo Sansovino; Andrea Cappello

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Academic Editors: Letizia Bonizzoni, Valeria Comite, Anna Galli and Rosina Celeste Ponterio

Received: 19 November 2024
Revised: 13 January 2025
Accepted: 20 January 2025
Published: 7 February 2025

Citation: Tuniz, C.; Marzaioli, F.; Terrasi, F.; Passariello, I.; Porzio, G.; Molaro, P. Radiocarbon Ages of a Possible Titian Painting. *Heritage* **2025**, *8*, 63. https://doi.org/10.3390/heritage8020063

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1. Introduction

This study is aimed at providing a time window for the execution of an old painting by means of radiocarbon dating. The painting was previously analyzed with scanning macro X-ray fluorescence (MA-XRF) using the mobile LANDIS-X instrument developed at the XRAYLab of ISPC-CNR and INFN-LNS in Catania [1]. The MA-XRF analysis showed that the pigments are consistent with paintings of the 16th century and also revealed the presence of a restoration, probably made in the 19th century [2]. The interest in this painting, shown in Figure 1, stems from the fact that the artist could be Titian or someone from his entourage, or from the workshop of Tintoretto, as suggested by the Italian Ministry of Art and Culture. In fact, the X-ray analysis revealed the notable absence of an underlying drawing, which is a characteristic of Titian's style. A resemblance with Titian's physiognomy was also noted in the sitter and it was suggested that it may be the lost self-portrait made around 1537 and mentioned by Vasari in his *Lives of the most Eminent Painters, Sculptors and Architects* [2].

However, more recently, the sitter has been more convincingly identified with the *Procuratore de Supra* Andrea Cappello (?-Venice, 1565) due to the similarity to a portrait by Jacopo Tintoretto, which belongs to the Accademia Gallery of Venice (inv. n. 121; cat n. 234; Dalla Costa, in prep). This painting shows an identical drawing of the sitter's face (Figure 2). It is interesting to note that the Tintoretto painting at the Accademia Gallery was historically attributed to Titian, and that the attribution returned to Tintoretto only in the

18th century. The file of the Accademia Gallery dealing with the Tintoretto painting reports: *the influence of the Cadore artist is clearly evident. The psychological rendering of the character is in fact of the highest quality: the Procuratore seems to slip out of the shadows and observe the spectator with a hard and inquisitive gaze and the firmness of the Cappello is further underlined by the closed hand clutching a white handkerchief that emerges from under the crimson tunic. The pictorial modeling, firm and robustly innervated, also helps to avoid any pause or ornamental underlining and to emphasize the energetic face of the Procuratore.* (Authors' translation of the text available at https://www.gallerieaccademia.it/il-procuratore-andrea-cappello, accessed on 5 January 2025).



Figure 1. The painting under study, oil on canvas 90 × 70 cm, private collection.



Figure 2. Jacopo Robusti detto Tintoretto, *Il procuratore Andrea Cappello*, olio su tela, cm 115 × 86, cat 234, © Archivio fotografico G.A.VE—"su concessione del Ministero della Cultura—Gallerie dell'Accademia di Venezia". On the right, the painting bears the Cappello coat of arms and the initial 'A' of Andrea Cappello. The similarity with the sitter of the painting shown in Figure 1 was found by Thomas Dalla Costa.

As both the artist and the sitter of the painting are unknown, the purpose of this radiocarbon study is to obtain useful elements to evaluate the extant attributions. The possible attribution to Tintoretto or Titian is very attractive since they are among the greatest painters of all times who made portraits of kings and popes and of the most important rulers of the 15th century. The state-of-the-art Accelerator Mass Spectrometry (AMS) radiocarbon dating was applied on a small fraction (tens of mg) of the specimens taken from the canvas and the frames of the painting. Radiocarbon measurements are based on the proportion of radiocarbon found in the sample and are reported in terms of radiocarbon age (RC age, *in years before present* (BP)), where *present* refers to 1950, and the half-life of ^{14}C is 5568 years assuming a constant atmospheric concentration of radiocarbon in the atmosphere. In order to derive the calendar age, the change in the atmospheric concentration of radiocarbon should be accounted for by applying calibration procedures. Radiocarbon ^{14}C ages cannot provide absolutely dated chronologies, but must be converted to calendar age equivalents using a calibration curve compensating for fluctuations in atmospheric ^{14}C concentration [3]. The main information comes from measurements on tree rings complemented by other samples of known age, which are compiled into calibration curves by the International

Calibration Group. The calibration curve is not monotonic, showing oscillations in the period relevant to this study producing multiple calendar ages for the same RC age.

This study is aimed at providing a time range for the canvas and frame to confirm that we are indeed dealing with a painting made during their lifetimes. Radiocarbon dating would either confirm or rule out the possibility that the painting was made by one of these artists or by their workshops. Titian's birth year is quite uncertain, ranging from 1477 AD to somewhere around 1490 AD, while Tintoretto was born in 1518 AD. The slight difference in their birth and the period in which they began to be active may offer some possibility of discriminating between them. Concerning the identity of the sitter, in the case of Andrea Cappello, the year of birth is not known but, his death was 1 February 1565. As discussed later, there are reasons to believe that the portrait could have been made before 1537 and possibly in the year 1523. On the other hand, if it were the lost self-portrait of Titian, it should have been painted around 1537.

2. Materials and Methods

The painting (Figure 1) comes from the collection of Giulio Parri and its story has been described in detail in [2]. A total of 4 samples were taken from the original canvas used for the painting. The original canvas appears very thin and drenched in color as it can be seen in the illustrative Figure 3. The back of the painting shown in Figure 3 reveals that the canvas was relined and the original is made of two pieces sewn together, as it was frequently made in ancient times. A sample from the canvas used for the relining was also collected. Note that both samples have been taken in the upper part of the two pieces of the canvas. The painting has a magnificent carved wooden handle frame covered by golden leaf. Two samples were taken from the main frame and one from the frame used to stretch the canvas. All samples have been numbered and placed in the plastic containers with an identification label. The photographic documentation of the sampling points is available on request. The weight of the sample material and the number of spots used are detailed in Table 1.



Figure 3. On the left: The back of the painting which shows the relined canvas and the two pieces of the original canvas sewn together. Note that the rabbet of the frame fits perfectly with the painting without signs of adjustment. The photos on the right show a sample collection from the painted canvas and the two frames.

Table 1. Samples used for the dating.

Sample Name	Sample Numbers	Mass (mg)
Painted canvas	4	360
Relining canvas	1	240
Wooden frame	2	327
Stretcher frame	1	178

One specimen of a few milligrams for each of the materials listed in Table 1 was radiocarbon dated. The analysis was performed at the CIRCE (Centre for Isotopic Research on Cultural and Environmental Heritage) Laboratory, Università degli Studi della Campania *Luigi Vanvitelli*, by means of an NEC (National Electrostatic Corporation) 3MV Tandetron-based Accelerator Mass Spectrometry System [3,4]. Before AMS analysis, samples underwent physical and chemical pretreatments with the aim of contamination removal and/or to isolate a useful carbon fraction for dating purposes. After a physical cleaning step, samples were chemically pretreated by the usual chemical processing procedure. In detail, first, α cellulose was extracted from both textile and wood specimens according to methods described in [5] to obtain more accurate results. In detail, together with the usage of typical acids and bases, a strong oxidant attack (sodium chlorite) in an acid environment was applied to samples to remove molecules other than cellulose (i.e., Lignin), potentially biasing measurements. This procedure was also tested successfully for other contaminant suppression (mostly preservatives) onto archaeological samples by the authors of [6]. Then, cellulose was combusted and graphitized by means of sealed tube combustion and zinc reduction, respectively. A sample of a sufficient mass capable to guarantee 1 mgC circa was weighed into pre-cleaned 6 mm quartz tubes with CuO, evacuated ($p < 10^{-6}$ mbar), flame-sealed, and combusted at 920 °C for 6.5 h. CO_2 produced during combustion was then cryogenically purified by other gasses and graphitized by sealing it into a Pyrex reactor, holding for Zn and TiH_2, and an inner vial holding Fe powder. Graphite was produced by letting the sealed reactors react @ 560 °C for 8 h.

Graphite specimens formed over the Fe powder during graphitization were pressed in Al cathodes and installed in the sputtering ion source of the accelerator, together with IAEA C3 [7] standard samples for normalization, OXII (NBS 4990c Oxalic Acid II) for quality check purposes, and Aesar graphite treated in the same way as other samples for background subtraction. $^{14}C/^{12}C$ isotopic ratios were measured at a terminal voltage of 2.55 MV exploiting the high-resolution capability of electrostatic and magnetic analyses performed both before and after ion acceleration. For each cathode, the raw $^{14}C/^{12}C$ ratios are given by the weighted average of 12 measurements. For unknown samples, $F^{14}C$ [8] values were obtained after normalization to the standard, background, and fractionation corrections using on-line $\delta^{13}C$ measurements. Typical 1σ uncertainties in the determination of $^{14}C/^{12}C$ isotopic ratios are of 0.3–0.5%. Finally, RC ages were expressed in years BP [8] and calibrated by means of OxCal software [9] using the INTCAL 20 [10] calibration dataset.

3. Results

Radiocarbon determinations calibrated by means of OxCal.v4.4 [9] and the IntCal20 atmospheric calibration dataset [10], together with the relative coverage for the calibration ranges, are reported in Table 2 and shown in Figure 4. Given the Suess effect on the atmospheric radiocarbon trend variation, represented by the calibration curves in the reference period (15th–17th century), the analysis formally provides two possible calendric intervals for all the samples. For the relined canvas and the the stretcher frame, the possible calendric age ranges are drastically enlarged by the Suess effect. For the painted canvas, the relative coverage probability (1σ) is of 61% for the years 1459–1521 AD and of 39% for the

years 1583–1623 AD for the 16th and 17th centuries. For the wooden frame, these are of 76% for the years 1524–1572 AD and 24% for the years 1630–1645 AD, respectively. The entire period from 1459 to 1657 (2σ C.L.) is permissible for the age of all materials. However, the uncertainty in the measurement results makes it challenging to further narrow down the time interval.

Table 2. Radiocarbon determinations (errors in brackets) calibrated by means of OxCal.v4.4 [9] and the IntCal20 atmospheric calibration dataset [10]. Relative coverage for the calibration ranges are also shown.

Sample Name	Radiocarbon Age (Years)	cal AD $\pm 1\sigma$	Rel. Cov. %	cal AD $\pm 2\sigma$	Rel. Cov. %
Painted canvas	368 (40)	1459–1521	61	1450–1530	50
		1583–1623	39	1540–1635	50
Wooden frame	296 (25)	1524–1572	76	1504–1597	71
		1630–1645	24	1616–1657	29
Stretcher frame	263 (38)	1524–1560	35	1497–1601	41
		1631–1667	53	1613–1680	44
		1783–1796	12	1740–1753	2
				1763–1800	12
				1940–1944	1
Relined canvas	79 (30)	1696–1724	32	1690–1729	27
		1812–1838	29	1807–1923	71
		1878–1951	39	1947–1954	2

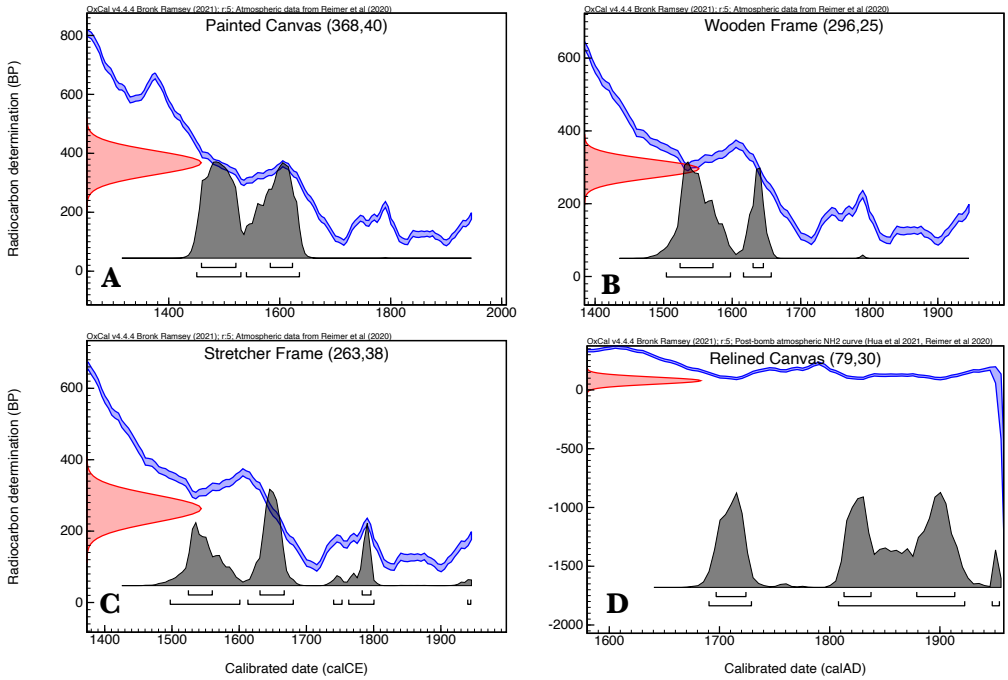


Figure 4. Observed calendric ages for the specimens from the painted canvas (**A**), the wooden frame (**B**), the stretcher frame (**C**), and the relined canvas (**D**). Measured RC ages with uncertainties are reported in brackets close to the sample name [9,10]. *X*-axis shows calendric ages curve and gray distributions show sample probability distributions.

Reported calendric ages for the main frame and the stretcher frame show that the two frames were coeval. In particular, this assures that the main frame is original and was not adapted later, for instance, at the time of relining. The relined canvas has 32% probability in 1696–1724 AD, and 29% in 1812–1838 AD with a sensitive residual

probability (i.e., 39%) in the period (1878–1951 AD) due to the Suess effect. This suggests that the painting was subject to a restoration which happened somewhere later than the 18th century. Indeed, the presence of anachronistic materials were detected by MA-XRF imaging. The presence of zinc white in the collar and in an extended area of the left side of the fur and clothes, with some traces also in the beard, hair, and hands, together with the presence of cadmium red on the shoulder and on the fur, was attributed to the restoration made towards the beginning of the 20th century, probably in the period 1910–1920 [2].

4. Discussion

Overall, due to the variability in the concentration of atmospheric radiocarbon during the reference period, the radiocarbon determinations of different materials provide a chronology for the painting as being executed in a large interval between 1459 and 1657 (2σ C.L.). However, stylistic aspects and previous pigment analyses suggest that both the 15th and the 17th centuries are unlikely. In the 16th century, the probabilities for the canvas and frames for the same set of solutions overlap only in the period 1507–1530 (2σ C.L.) and, therefore, we argue that this is the more likely range for the painting's execution. These arguments, admittedly speculative, produce some elements for the attribution of the painter and on the identity of the sitter. At face value, they rule out the possibility that the author of the painting is Jacopo Tintoretto, who was born in 1518, or someone from his workshop, as suggested by the Italian Ministry of Art and Culture. On the other hand, Titian's birth, although quite uncertain, ranges from 1477 to 1490 and is more consistent with the canvas's temporal window. In the early decades of the 16th century, Titian was already a famous painter. In 1530, he painted Charles V, and three years later, he was nominated *Pintor Primero* by the Emperor and honored with the title of Count Palatine and Knight of the Golden Spur. The *Venus of Urbino* painted for Guidobaldo della Rovere is of 1538, just to mention one of the most famous ones. Considering the self-portrait hypothesis, the painting should have been made around 1537 since Vasari saw one self-portrait of Titian during his first visit of 1541 AD [2]. The period refers to the period when Titian made the paintings in the renovated church of Santo Spirito under the direction of Jacopo Sansovino, who may be connected to the frame of the painting, as we will discuss in the next section.

4.1. The Frame

The frame shown in Figure 1, which has been found to be coeval to the canvas, or slightly more recent, is particularly interesting. It is hand-sculpted by a skilled carver and gilded with real gold leaf in a style which is clearly Sansovinian. The presence of decorative elements of an architectural nature is characteristic of the new style introduced by Sansovino. Sansovino, born Jacopo Tatti (Florence, 1486–Venice, 1570), was the most important architect of the Republic of Venice since his arrival in 1527 until his death. Thanks to his friendship with Pietro Aretino and Titian, Sansovino acquired a noble status and was admitted to the Venetian patriciate, thus becoming a member of the aristocracy governing *La Serenissima*. The time range obtained for the main frame is consistent with Sansovino's arrival in Venice, and his friendship with Titian could be an indirect element in favor of the attribution of the author of the painting. It is worth noting the similarity of the frame with that of the portrait of the doctor, astronomer, and poet Girolamo Fracastoro (1476 ca.–1553) executed by Titian in 1528 on display at the National Gallery in London, and Figure 5 shows details of the two frame carriers. Both the structure of the spiral as well as the face of the little angel have common executive features that refer to a common fabrication. Since Sansovino arrived in Venice in 1527, the frame which maintains Sansovino's style would have been crafted a few years later in agreement with the radiocarbon time range for the main frame.



Figure 5. On the right, a detail of the frame of the portrait of Girolamo Fracastoro (1476 ca.–1553) executed by Titian in 1528, National Gallery, London, NG 3949, vis à vis with that of the frame under study. The similarity in the executive features suggest the execution by the same hand and likely in the same years.

4.2. The Sitter

We now consider the suggestion that the sitter is the same Andrea Cappello as in the painting by Tintoretto belonging to the Accademia Gallery of Venice, inv. n. 121; cat n. 234, shown in Figure 2 (Dalla Costa, in preparation). A direct comparison with the Tintoretto's painting of the Academia shows that both paintings, even though one sitter is depicted at bust length and the other in three quarters, are copies. The most striking difference is that while one is wearing a fur coat, the other shows the formal dress of a Procuratore da Supra. The election as *Procuratore* was a lifetime appointment in the government of the Venetian Republic and was considered second only to that of Doge. There were three categories of Procuratore, with different responsibilities and areas of the city, with the Procuratori de Supra, administering the Basilica di San Marco, being the most prestigious. The *Procuratore de Supra* wore a characteristic tunic *color cermesi*, i.e., crimson red, and is always portrayed in this way. See, for instance, the Tintoretto portraits of other *Procuratori de Supra* such as Jacopo Soranzo, Antonio Cappello or the portrait of the procurator Contarini by Domenico Tintoretto.

The two paintings differ in size. The one at the Accademia is considerably larger, measuring 115 × 86 cm. Generally, copies are smaller than the original; however, in our humble view, the one made by an anonymous painter is of comparable quality, suggesting that the artist was a very talented painter. According to what bf was reported by Francesco Sansovino, son of Jacopo, at page 238 of his book *Venetia, città nobilissima, et singolare, Descritta in XIIII libri*, published in 1581, Andrea Cappello became *Procuratore de Supra* in the year 1537 [11,12]. This is also supported by the letter by Pietro Aretino dated 22 September 1537, where he congratulates Iacopo Cornaro, Andrea Capello, and Giulio

Contarini for the election as Procuratore. A portrait of a Procuratore de Supra without the characteristic *cermesi* dress is very unlikely. For this reason, the portrait of Andrea Cappello without the red crimson dress should have been executed before the year of his appointment, namely before 1537, while the one of the Accademia would have been made after 1537. Note that the 1537 bound is marginally consistent with the temporal ranges both of the canvas and of the frames.

The Accademia Gallery reports that the painting by Tintoretto had a writing which has been removed in a recent restoration in 1959. The writing specified that the sitter was Andrea Cappello and was coming from the *Procuratoria de Supra*. Furthermore, the writing also bore the date 1523. This year remains mysterious, but we can speculate that it could be the year when Andrea Cappello was portraited alive before becoming Procuratore and copied much later by Tintoretto for the Procuratoria. It is also possible that Tintoretto made it after Cappello's death in 1565 and copied the face from the other painting. We note that a misidentification of the sitter by Tintoretto could have made it possible to mistakenly interpret the painting as a Titian self-portrait, as argued in the work of Molaro et al. [2].

5. Conclusions

Radiocarbon determinations calibrated using the code OxCal. v4.4 (Bronk Ramsey, C. 2021. OxCal v.4.4.4 URL: https://c14.arch.ox.ac.uk/oxcal.html, accessed on 5 January 2025) and the updated IntCal20 atmospheric curve [10] for different components of the canvas and the frames of a possible painting by Titian have provided two calendar solutions separated by about one century, spanning the whole period from 1459 and 1657, at 2σ C.L. However, only solutions within the 16th century are supported by stylistic arguments and by the results of the scanning macro X-ray fluorescence. Within this century, we have found the following:

- The main wooden frame provides the highest probability for the time range 1504–1597 (2σ, C.L.). The wood of the frame is handmade, beautifully carved, and covered by a golden leaf. It shows Sansovino's style and the radiocarbon date is consistent with the arrival of Jacopo Sansovino in Venice in 1527. A striking similarity of the frame with that of the portrait of Girolamo Fracastoro (1476 ca.–1553) executed by Titian in 1528 and on display at the National Gallery in London, NG 3949, is found to suggest the same hand and a similar period. The stretcher frame is also studied, providing a time range of 1497–1601 (2σ) cal AD. The stretcher frame is therefore found coeval with the main frame.
- The time range for the painted canvas falls in the period 1450–1530 cal AD, 2σ C.L. The dating of the canvas appears to be slightly prior to that of the wooden frames. However, the time range defines the manufacturing period of the canvas, which could be a few years earlier than it was painted, in particular for a canvas like this one, which was obtained by sewing two remnants.
- The relined canvas has two relatively distinct solutions for the time range, which are 1690–1729 (2σ) and 1807–1923 (2σ) with coverage probabilities of 27% and 71%, respectively. It is likely that the lining took place during the restoration of the painting estimated somewhere after the 18th century. This is consistent with the MA-XRF analysis that revealed the presence of a restoration, probably made in the 19th century [2].

Thus, the obtained radiocarbon determinations combined with stylistic considerations suggest a chronology for the painting as having being executed in the 16th century and likely before 1530. As such, the result seems to disfavor the possibility that the author of the painting is Jacopo Tintoretto or his workshop, while it is compatible with Titian or his workshop. As for the sitter, the result is consistent both with a self-portrait made by Titian around 1537 or with a portrait of Andrea Cappello made before 1537, i.e., the year when

Cappello was appointed *Procuratore de Supra*. One intriguing possibility is that the sitter is Andrea Cappello and the date of the painting is 1523, which is the year written on the portrait of Andrea Cappello made by Tintoretto and belonging to the Accademia Gallery. This is also very close to 1528, the execution year of the portrait of Fracastoro by Titian, which shows a very similar frame.

Author Contributions: C.T. contributed in the data collection, data analysis, and writing; F.M., F.T., I.P. and G.P. carried out the measurements in the laboratory; P.M. contributed to the writing of the discussion. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The painting studied in this article can be made available by the authors on request under a collaborative approach and permission of the owners.

Acknowledgments: We warmly thank Irka Hajdas for discussions and comments on the manuscript. We acknowledge Luba Freedman for pointing out the Sansovinian style of the frame and Thomas Dalla Costa for the convincing identification of the sitter with the Procuratore de Supra Andrea Cappello. P.M. sincerely thanks Raymond Waddington and Charles Hope for enlightening considerations about the painting. Gabriella Schiulaz is acknowledged for checking the writing.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

MA-XRF	Macro X-Ray Fluorescence
CIRCE	Center for Isotopic Research on Cultural and Environmental Heritage
NEC	National Electrostatic Corporation
BP	Before Present
RC	Radiocarbon
AMS	Accelerator Mass Spectrometry

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