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## Historical Background and General Observations

Almagest

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### Abstract

This paper presents a detailed account of the history of the fragments of the Antikythera Mechanism preserved in the National Archeological Museum, Athens, with particular attention to previous transcriptions and paleographical appraisals of the inscriptions in the fragments. The paper concludes with general observations about the technique and paleography of the inscriptions.

## 2.1 Modern history of the fragments

The initial discovery and first interpretations of fragments of the Antikythera Mechanism were reported on a day-to-day basis in several Athenian newspapers (Table 2.1).<sup>1</sup> These reports appear generally to have been published the day after they were written or, in the case of evening newspapers, sometimes on the same day. Notwithstanding a few obscurities and inconsistencies, they allow us to reconstruct the story of those days in some detail.

YEAR	MORNING				EVENING		UNKNOWN	
	<i>To Asty</i>	<i>Skrip</i>	<i>Embros</i>	<i>Akropolis</i>	<i>Neon Asty</i>	<i>Estia</i>	<i>Eleutheros Typos</i>	<i>Sphaira</i>
1901/7/24	1?	1?						
1902/5/21	1	1						
1902/5/22		1			1	1		1
1902/5/23	1	1		1	2	1		
1902/5/24	1					1	1	
1902/5/25		1	1		1			
1902/5/29	1							
1902/5/30	2							
1902/5/31	2							
1902/6/1				1				
1902/6/4	1							
1902/6/23	1							
1902/6/24	1							
1902/12/13	1							
1902/12/14	1							
1902/12/18	1							

Table 2.1: *Articles in Greek newspapers relating to the discovery of the Antikythera Mechanism's fragments*

1 Partial lists of the reports in Svoronos 1903a, 15-17, note 1 (from second column of p. 15) translated into German = Sovronos 1903b, 15-17, note 1 (from second column of p. 15); Price 1974, 9-10; Fragkou 2010a, 28-35, translated into English = Fragkou 2010b, 27-33. Scans of many newspapers of the time are currently accessible through the websites of the Library of the Parliament of Greece, <http://catalog.parliament.gr>, and the Greek National Library, <http://efimeris.nlg.gr/ns/main.html>. Additionally, the database "Archaeological events in Greek press (1832-1932)" of the Aristotle University of Thessaloniki (<http://invenio.lib.auth.gr>) contains transcriptions of numerous articles relating to the Antikythera wreck and the Mechanism. Some articles are reproduced in Fragkou 2010a, 65-71 = Fragkou 2010b, 62-67, and in Nikoli 2012, 16-87. Among those cited below, *Νέον Αστυ* and *Εστία* were evening newspapers. The available collections of the newspapers have occasional gaps, and I may have overlooked some pertinent articles.

The newspapers credit the discovery of the fragments in the National Archaeological Museum to Spyridon Stais (1859-1932), a representative of the island of Kythera in the Greek parliament who had served from May 27, 1900 to November 25, 1901 (Julian calendar)<sup>2</sup> as Minister of Education in the government of Georgjos Theotokis. Stais was not an archeologist; he had studied mathematics and physics and taught mathematics in schools before his political career.<sup>3</sup> As minister, however, he had negotiated the Greek government's support of the salvage of the Antikythera wreck in 1900-1901, and continuing interest in the outcome of this project suffices to explain his visit to the Museum, apparently on Saturday, May 18, 1902 (but possibly on Monday, May 20), together with his wife and sister-in-law, a Miss Vouya.<sup>4</sup> Stais was shown a room where unidentified bronze fragments from the wreck were stored in the hope that they might yield pieces of the so-called "Youth of Antikythera" statue, and among them he noticed two or three objects, described in the reports as "slabs" or "plates" (πλάκες), on the surfaces of which one could see toothed gears and an inscription in mirrored writing. The fragment bearing the gears must have been the one now called Fragment A, while the one with the mirror inscription was surely the present Fragment B.<sup>5</sup> Little or nothing of this inscription was read on that day.

Descriptions of the fragments in less ephemeral and more scholarly Greek publications

2 The Julian calendar was employed in Greece until 1923. Dates cited here from Greek sources before 1923 are therefore Julian unless otherwise indicated. Their Gregorian equivalents are thirteen days later; e.g. June 1 (Julian) is June 14 (Gregorian).

3 Biography in *Μεγάλη Ἑλληνική Ἐγκυκλοπαίδεια* 22, 269-270. The contemporary reports are consistent in their identification of the discoverer, typically qualified as "the former Minister of Education" or the like.

4 The first and most circumstantial reports are in *Σκρίπ* no. 2428, May 21, 1902, p. 4 ("Σπουδαία ἀνακάλυψις διὰ τὰς ἀρχαιοστῆτας τῶν Κυθήρων"), and *Τὸ Ἄστυ* no. 4139, May 21, 1902, p. 1 ("Σπουδαία ἀνακάλυψις ἐν τῷ Ἐθνικῷ Ἀρχαιολογικῷ Μουσεῖῳ"). In both, the discovery is said to have occurred "yesterday" (i.e. Monday, May 20), and "the day before yesterday" in a report published on May 22 ("Δύο ἐνεπίγραφα τεμάχια ἀπὸ τὰ Ἀντικύθηρα", *Νέον Ἄστυ* no. 162, 2). On the other hand, *Ἐστία* year 9 no. 82, May 22, 1902, p. 4 ("Ἡ πλάξ τοῦ Μουσεῖου μας") and *Τὸ Ἄστυ* no. 4141, May 23, 1902, p. 1 ("Ἡ ἐνεπίγραφος πλάξ τῶν Ἀντικυθήρων") date the discovery to "last Saturday" (i.e. May 18), which may reflect a correction of the information provided to the first reporters.

5 Fragment A is the only one bearing a complex of gears matching the descriptions in the reports in *Σκρίπ* and *Τὸ Ἄστυ*. Parts of the mirror-writing inscription are found on both Fragments A and B, but the part on A was almost entirely concealed by other material as late as 1903, and no one except Rehm seems to have been aware of its existence at this time, or indeed until the time of Price and Stamires in the 1950s. According to the report in *Τὸ Ἄστυ* Stais discovered *three* fragments (while *Σκρίπ* is vague about the number). If correct, these would presumably have been A, B, and C; but this is hard to reconcile with the subsequent report (see immediately below) that a third fragment, apparently C, was found only on May 21.

from 1902 through 1910 (after which the Mechanism fell into neglect for almost two decades) did not mention the circumstances under which they came to notice. Later accounts introduced elements of confusion that continue to infect the secondary literature on the Mechanism. Ioannis Theofanidis (1877-1939),<sup>6</sup> who studied the Mechanism in the 1920s and 1930s, was probably relying on recollections (his own or that of people he consulted) when he wrote in the late 1920s that “the then [*sic*] minister of education, Mr. Sp. Stais [...] by complete chance saw it cast down outside the door of the Archaeological Museum, among many other fragments found there, where the useless bits were put that had been separated from the works of art while they were being cleaned”.<sup>7</sup> Price, on the other hand, got the right setting but the wrong protagonist when he wrote in 1959 that “Valerios Stais, an archaeologist at the National Museum, [recognized the fragments of a mechanism while] examining some calcified lumps of corroded bronze that had been set aside as possible pieces of broken statuary”.<sup>8</sup> Throckmorton subsequently repeated this story with the additional false details that Valerios Stais was a young man and Spyridon’s nephew;<sup>9</sup> they were in fact first cousins, and Valerios (1857-1923) was about 45 years old (two years older than Spyridon) and the director of the Museum. Price’s 1974 account of the discovery, based on a selection of newspaper reports from May 23, 1902 onwards, was in most respects correct.<sup>10</sup> Nevertheless, Valerios Stais continues to receive spurious credit for first noticing the fragments.<sup>11</sup>

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6 Biography in *Μεγάλη Ελληνική Έγκυκλοπαίδεια* 12, 542 and suppl. 3, 78.

7 Theofanidis [1927-1930], “97” [correct pagination: 89] with note 3. More recent assertions (e.g. Marchant 2008, 37) that the unassigned fragments from the wreck among which the Mechanism was discovered were stored in the open air appear on the face of it implausible. Theofanidis dates Stais’s discovery to just a few days after the fragments had been recovered from the wreck site; in reality the interval must have been the better part of a year.

8 Price 1959, 61. Despite the slip, his version shows that he must already have had access to some newspaper accounts.

9 Throckmorton 1970, 153. Biographies of Valerios Stais in *Μεγάλη Ελληνική Έγκυκλοπαίδεια* 22, 269; Oikonomos 1922; Petrocheilos 1992. Valerios Stais’s father Nikolaos and Spyridon’s father Emmanuel (1817-1895) were sons of Valerios Stais, representative of Kythera in the 1817 Assembly of the Ionian Islands established under Maitland’s British administration (information courtesy of Marina Papadimitriou).

10 Price 1974, 9. Price’s history of the events of 1900-1905 is not quite free of errors. Not realizing that the Greek calendar of the time was the Julian, Price assigned incorrect weekdays to the newspaper issues and dated the Saturday when Stais was reported to have made the discovery as May 17, one day too early. He also followed Throckmorton in identifying Spyridon Stais as a “prominent archaeologist” (p. 8), and makes him the author of Valerios Stais’s 1905 monograph on the wreck (p. 11) — in fact by 1974 Price seems to have forgotten that Valerios existed!

11 Marchant 2008, 37-38, offers a new variation, according to which an “unnamed

Price expressed surprise that “such exciting pieces” could have gone unnoticed for so many months until Spyridon Stais’s chance visit to the Museum.<sup>12</sup> In fact it is highly probable that they *were* noticed immediately upon their having been brought out of the sea. Valerios Stais wrote in 1905 that the Mechanism was recovered “around the end of the period of salvage of the antiquities of Antikythera,” which would mean the summer of 1901.<sup>13</sup> By this stage it appears that the divers were attempting a systematic clearing of all the antiquities, now chiefly smaller and more mundane objects that they were able to reach.<sup>14</sup> On July 24, two newspapers reported a telegram received by the Ministry of Education from the work site. *Τὸ Ἄστυ* —in general the most thorough and reliable of the Athenian newspapers in its archeological coverage— stated that:<sup>15</sup>

“a single inscribed slab [πλάξ] was found, the letters on which, however, could not be copied. Besides this were found vases, fragments of statues, and other ancient objects”.

*Σκρίπ* reported the finding of a “marble slab bearing a difficult-to-read inscription”.<sup>16</sup> No inscription on stone has been identified among the objects from the Antikythera wreck in the Museum; the only things that could be described as an inscribed “slab” (as in fact they were, repeatedly, in the newspapers in 1902) were the fragments of the Mechanism.<sup>17</sup> It seems likely that the reporter for *Σκρίπ* simply assumed that an inscribed slab *ought* to be marble!

\_\_\_\_\_ museum worker noticed the significance of the decaying, fractured lump” and notified Valerios about it. In case any doubt lingers concerning the identity of the discoverer, we have Valerios’s own testimony (“Αἱ ἀρχαιότητες τῶν Αντικυθήρων”, *Τὸ Ἄστυ* no. 4343, December 13, 1902, 1-2) that they were found by “the former minister, Mr. Stais.”

12 Price 1974, 9.

13 Stais 1905, 18. The salvage was terminated on September 30, 1901 (Svoronos 1903a, 15 = 1903b, 14); a letter of Stais to Kavvadias dated November 24 of an unstated year, adduced by Petrakos 1991 as evidence of a revival of the campaign in November, 1901, actually must date to a later, now largely forgotten unsuccessful attempt to revisit the wreck site in the winter of 1905-1906 that was extensively reported in the Athenian newspapers of the time.

14 Throckmorton 1970, 151, supported by newspaper reports listing the objects found. In particular *Τὸ Ἄστυ* no. 3835, July 13, 1901, summarizes a report to Spyridon Stais from his representative at the site, according to which the divers were working slowly but systematically to recover all objects down to a depth 1 meter below the surface of the sea bottom and as far down as 35-40 fathoms (64-73 meters), the limit of their diving range.

15 *Τὸ Ἄστυ* no. 3846, July 24, 1901, p. 2.

16 *Σκρίπ* no. 2132 [misprinted 2142], July 24, 1901, p. 2.

17 I am indebted to John Seiradakis and Magdalini Nikoli for directing me to the newspaper articles from July 24, 1901.

In connection with these contemporary reports, it deserves mention that Theofanidis also wrote of a “first” discovery of the Mechanism preceding Stais’s.<sup>18</sup> The discoverer, according to Theofanidis, was his fellow naval officer, Perikis Rediadis (1875-1938),<sup>19</sup> who at the time held the rank of sublieutenant (ἀνθυποναυλοίαρχος) and was assigned to the troopship *Mykali*, the vessel that was put into service on several occasions during the period of salvage transporting antiquities from Antikythera to Athens and carrying archeologists and representatives of the Ministry of Education back and forth.<sup>20</sup> According to Theofanidis, the Mechanism was so encrusted with marine accretions that the petty officer who was loading the antiquities on the deck of the *Mykali* nearly tossed it overboard as worthless, but was prevented from doing so by Rediadis, who had noticed a piece of metal projecting from a broken face of it. Theofanidis must have heard this story directly from Rediadis, and it may have undergone some distortion in the quarter century since the events it describes.<sup>21</sup> Rediadis was later to publish several articles on the Mechanism, and none of them mention this incident.<sup>22</sup> In any case, it could not have occurred on the date shortly before July 24 when the Mechanism seems to have been brought to the surface, because the *Mykali* was not at Antikythera at that time, and only arrived there at the beginning of August with Spyridon Stais aboard, to collect the salvaged objects that had accumulated over the summer. This assemblage, including the Mechanism, arrived at Piraeus to be taken to the Museum on August 3.<sup>23</sup>

Taking into consideration, with all due caution, the newspaper reports from July 24, 1901,

18 Theofanidis [1927-1930], 83 with note 6.

19 Biography in *Μεγάλη Ελληνική Έγκυκλοπαίδεια* 21, 84, and [Anonymous] [1939?].

20 According to Svoronos (1903a, 44 note 2 = 1903b, 43 note 1), Rediadis went to Antikythera five times on board the *Mykali*.

21 Theofanidis commits errors that reveal that he did not extensively consult contemporary published sources; thus he writes that the wreck was salvaged by sponge divers from Kalymnos in 1902, getting both the island and the year wrong.

22 *Τὸ Ἄστυ* no. 4171, June 23, 1902, p. 2 and no. 4172, June 24, 1902, p. 2; “Ὁ ἐξ Ἀντικυθήρων ἀστρολάβος”, in Svoronos 1903a, 44-52 (= “Der Astrolabos von Antikythera,” in Svoronos 1903b, 43-51); Rediadis 1903; Rediadis 1910.

23 Among the objects that arrived in Athens with Stais on August 3, the one that got the most attention was a well preserved bronze statuette of a youth missing its right arm (now National Archaeological Museum X 13399, with the arm restored from the 1974 Cousteau excavations, X 18960); see *Ἑστία* year 8 no. 149, August 3, 1901, p. 3, *Τὸ Ἄστυ* no. 3857, August 4, 1901, p. 1, *Νεολόγος* no. 1430, August 4, 1901, p. 1, *Καιροί* no. 4510, June 23, 1901, p. 2, and *Ἐμπρός* no. 1712, August 4, 1901, p. 2. The discovery of the statuette had been reported already by telegram six weeks earlier (*Ἐμπρός* no. 1670, June 23, 1901, p. 2, and *Ἀκρόπολις* no. 6938, June 23, 1901, p. 3), which shows that this was the first delivery of finds from Antikythera since the beginning of the summer. Oddly, the majority of the newspaper reports identify the lost arm as the *left* one.

Theofanidis's story, and the general character of the salvage operations during the summer of 1901, there is good reason to believe that the separate fragments A, B, and C (and possibly also D, E, and F which were found in the Museum subsequently) came into being through the breaking up of a single "slab" after it had come out of the sea, as Price hypothesized.<sup>24</sup> Such a composite would have borne on one face the hard-to-read mirror-writing inscription that Stais later noticed on Fragment B, while the other face would have been almost entirely featureless except perhaps for some illegible traces of direct inscription that Rediadis later reported on Fragment C.<sup>25</sup> The gears and other mechanical elements that were so conspicuous on Fragments A and C in 1902 would have been concealed inside the composite slab. It is difficult to believe that these mechanical elements would have escaped notice in the summer of 1901 if they had been exposed. Price supposed that the gradual drying out of the object could have caused stresses that led to its fragmentation, but given the fragility of the calcified materials that compose the present fragments, one could just as well suppose that it broke apart as a result of a casual impact.

Let us return to the story of the fragments immediately following Stais's visit to the Museum. On Tuesday, May 21, several archeologists including Gavriel Vyzantinos (1868-1910),<sup>26</sup> an Ephor (i.e. superintendent) of Antiquities who had been involved in the salvage of the wreck, inspected the fragments, and a further fragment —presumably the present Fragment C— equal in size to the smaller of the other two —presumably B— was reportedly found.<sup>27</sup> Vyzantinos informed reporters of a few letters that had been read on the fragments; these can be identified as parts of a direct-writing inscription on Fragment A and of the mirror-writing inscription on Fragment B.<sup>28</sup> On Wednesday, Adolf Wilhelm (1864-1950),

24 Price 1974, 10. On the other hand, Theofanidis ([1927-1930], "97" [correct pagination: 89] with note 3) alleges, we do not know on what authority, that the sponge divers who salvaged the wreck deliberately shattered unidentified objects to determine whether they were antiquities or mere "fossils."

25 Svoronos 1903b, 46. The illegible letters mentioned by Rediadis were probably part of the inscription on the present Fragment G, which was separated from C after 1903.

26 Vyzantinos was the assistant of the General (i.e. chief) Ephor of Antiquities, P. Kavvadias, cf. Petrakos 2011, 20, where he is characterized as "undistinguished and [...] without accomplishment". Biographical information about Vyzantinos is scarce. He was appointed Ephor in 1898, having previously been director of the National Lyceum (*Τὸ Ἄστυ* no. 2883, November 22, 1898, p. 2), briefly succeeded Kavvadias as General Ephor in 1910, but died (by suicide) in that year (Petrakos 2013, v. 1, 256-257). He had supervised the earlier stages of the salvage at Antikythera in late 1900 and early 1901, and wrote a valuable short account of them (Vyzantinos 1901a, translated into English: Vyzantinos 1901b).

27 "Αἱ χαλκαὶ πλάκες τῶν Ἀντικυθῆρων", *Νέον Ἄστυ* no. 163, May 23, 1902, p. 2.

28 "Αἱ ἀρχαιοτήτες τῶν Ἀντικυθῆρων", *Σκρίπ* no. 2429, May 22, 1902, p. 3; "Δύο ἐνεπίγραφα τεμάχια ἀπὸ τὰ Ἀντικύθηρα", *Νέον Ἄστυ* no. 162, May 22, 1902, p. 2.



an epigrapher and the secretary of the Austrian Institute in Athens, and the numismatist Ioannis Svoronos (1863-1922)<sup>29</sup> spent several hours attempting to read and estimate the date of the mirror-writing inscription on Fragment B.<sup>30</sup> On Thursday, Konstantinos Rados (1862-1931, a naval historian),<sup>31</sup> Valerios Stais, Panagiotis Kastriotis (1859-1931, another Ephor of Antiquities), and Wilhelm inspected the fragments.<sup>32</sup> Photographs were made on May 28.<sup>33</sup> On June 23, the newspaper *Τὸ Ἄστυ* published an article by Rediadis containing the first detailed description of the fragments, which leaves no doubt that the only fragments known at this stage were the present Fragments A, B, and C.<sup>34</sup>

The last issue of the 1902 volume of the journal *Ἐφημερίς Ἀρχαιολογική*, published on February 15, 1903, contains a long anonymous report of the finds from the Antikythera wreck. It includes a rather cursory description of the fragments (not even specifying how many there were), but stating that, at the date of writing, they had undergone no conservation ("it still remains as it was removed from the sea").<sup>35</sup> A photograph shows the face of Fragment B bearing the mirror-writing inscription.

About June 1903, the first fascicle (plates and text) of volume 1 of Svoronos' illustrated

29 Biography in *Μεγάλη Ἑλληνική Ἐγκυκλοπαίδεια* 22, 605.

30 "Δύο ἐνεπίγραφα τεμάχια ἀπὸ τὰ Ἀντικύθηρα", *Νέον Ἄστυ* no. 162, May 22, 1902, p. 2; "Ἡ πλάξ τοῦ μουσείου μας", *Ἑστία* year 9 no. 83, May 22, 1902, p. 4; "Ἡ χάλκινη πλάξ τῶν Ἀντικυθέρων", *Σκρίπ* no. 2430, May 23, 1902, p. 2; "Ἡ ἐνεπίγραφος πλάξ τῶν Ἀντικυθέρων", *Τὸ Ἄστυ* no. 4141, May 23, 1902, p. 1; "Αἱ χαλκαὶ πλάκες τῶν Ἀντικυθέρων" (a very circumstantial report) and "Τὸ ἀστρολάβον τῶν Ἀντικυθέρων", *Νέον Ἄστυ* no. 163, May 23, 1902, p. 2.

31 Biography in *Μεγάλη Ἑλληνική Ἐγκυκλοπαίδεια* 21, 23.

32 "Τὸ περίεργον εὔρημα τῶν Ἀντικυθέρων", *Τὸ Ἄστυ* no. 4142, May 24, 1902, p. 1; "Αἱ χαλκαὶ πλάκες τῶν Ἀντικυθέρων", *Νέον Ἄστυ* no. 165, May 25, 1902, pp. 1-2.

33 "Τὸ ἀνεξήγητον μηχανήμα τῶν Ἀντικυθέρων", *Τὸ Ἄστυ* no. 4147, May 29, 1902, p. 1. It is not known whether the photographs subsequently published in [Anonymous] 1902 and Svoronos 1903a/1903b were from this session.

34 "Ὁ ἀστρολάβος τῶν Ἀντικυθέρων", *Τὸ Ἄστυ* no. 4171, June 23, 1902, p. 2. A continuation of this article, under the same headline, appeared in no. 4172, June 24, 1902, p. 2.

35 [Anonymous] 1902; the description of the Mechanism is cols. 170-172 with the photograph as text figure 14 on cols. 165-166. Svoronos (1903a, 16 = 1903b, 16) tells us that the article was a collaboration of several of the leading Greek archeologists of the time, Valerios Stais, Christos Tsoundas (1857-1934), and Konstantinos Kourouniotis (1872-1945), under the direction of Panagis Kavvadias (1850-1928). Kavvadias was also the source of information for one of the earliest published mentions of the Mechanism in a language other than Greek, Vicars 1903, 562. (Its discovery in the Museum had already been briefly reported in the London newspaper, *The Standard*, Saturday, June 7, 1902, p. 7 — the corresponding Julian calendar date in Greece was May 25).

survey of the Museum's antiquities, devoted to the Antikythera wreck, was published in Greek, with a German translation appearing soon after; this work incorporates a section by Rediadis on the Mechanism's fragments.<sup>36</sup> Rediadis describes four fragments, designated for the first time by the letters A, B, C, D (Fragment D is mentioned here for the first time), and Plate X presents photographs of both faces of all four fragments (specimens for A-2 and C-1 in supplementary Figs. S6 and S9), with a larger reproduction of B-1, the mirror-writing face of Fragment B, on Plate IX (supplementary Fig. S8).<sup>37</sup> This photograph is not the same as the one in *Εφημερίς Αρχαιολογική*, but the condition of the fragment is indistinguishable. Rediadis speaks of the extremely fragile state of the fragments, so that they break "on the application of the slightest force that the hand of the conservator can apply to it", which perhaps is an indication that conservation had begun — though if so, it had certainly not progressed very far, if we may judge by the photographs and by the very limited amount of inscriptional text reported by Rediadis on the authority of Svoronos and Wilhelm.

The conservation had been entrusted to the chemist Othon Rousopoulos (1855-1922),<sup>38</sup> who was responsible also for the conservation of other bronze artifacts in the Museum at that time.<sup>39</sup> There were two elements involved in the conservation of the Mechanism's fragments:

36 Svoronos 1903a, 44-52, and 1903b, 43-51. The chronology of these publications (self-described not as a catalogue but as a series of plates with explanatory text) has been a matter of confusion in scholarship on the Mechanism since Price's time. The title pages of both the Greek and German editions of the Antikythera fascicle bear the date 1903. An announcement of the Greek edition in the biweekly periodical *Παναθήναια*, issue of June 30, 1903, 573-574, confirms that this edition was published by the middle of 1903, while the German edition was advertised on the back pages of the *Mitteilungen des Kaiserlichen deutschen archäologischen Instituts, Athenische Abteilung* 28 (1903), published soon after February 24, 1904. The relative order of publication of the two editions is indicated by an error in the account of the inscriptions of the Mechanism's fragments in the Greek edition (p. 46, an inscription said to be on Fragment C that is in fact on Fragment A) that is corrected in the German. The title page provided for the text section of the German edition when volume 1 was completed bears the date 1908, and many bound copies lack the original 1903 title page; the title page of the Greek edition of the completed volume 1 has no date.

37 The principal fragments were never designated in print by Greek letters, as stated in Wright 2006, 322.

38 Biography in *Μεγάλη Έλληνική Έγκυκλοπαίδεια* and *Μέγα Έλληνικόν Βιογραφικόν Λεξικόν* 1, 85-103.

39 The fragments were placed for safekeeping in a glass cabinet and assigned to Rousopoulos immediately after they were photographed on May 28, 1902 ("Τὸ ἀνεξήγητον μηχανήμα τῶν Αντικυθήρων", *Τὸ Ἄστυ* no. 4147, May 29, 1902, p. 1), and it was expected that the work would begin within a few days ("Αρχαιολογικά," *Τὸ Ἄστυ* no. 4153, June 4, 1902, p. 2.). In fact, in the light of the remarks in the *Εφημερίς Αρχαιολογική* report it appears

removal of extraneous matter and corrosion products from the surfaces to restore them to a semblance of their ancient appearance (καθαρισμός, *Reinigung*, literally "cleaning"), and separation of components that had become fused together. Since separation exposed new surfaces for cleaning, the process was iterative. In a presentation to the International Archeological Congress at Athens on March 29, 1905, Rousopoulos described his preferred technique for cleaning bronzes as a reduction by means of zinc and hydrochloric acid.<sup>40</sup> But since this was not applicable in the case of objects such as the Mechanism's fragments that were corroded to the point that little or no free metal survived, he reports that he subjected them instead to a treatment with potassium cyanide, a reagent widely used in the conservation of metal artifacts at that time.<sup>41</sup> He speaks of the "difficulty and riskiness of the delicate task" of cleaning the Mechanism, "a real test of patience and endurance". Once cleaned, the fragments were protected by an application of Zapon lacquer.

The challenge that Rousopoulos faced in the case of the Mechanism was to remove obscuring layers of accreted matter mixed with corrosion products without also mutilating or destroying "original" surfaces that were themselves by now composed of corrosion products. In this he appears to have been largely successful. Some loss of surface detail would, however, have been unavoidable in any treatment by reduction, the more so as the treatment was prolonged. The indistinctness of the lettering on some of the inscribed fragments in their present condition is probably due in part to this chemical cleaning, and in part to bits of the inscribed surface coming off with the accretion layers when they were separated.

The state of Fragments A, B, C, and D in October 1905 is documented by a set of photographs made by Georg Karo (1872-1963), the second director of the Athenian branch of the German Archeological Institute, for the philologist and epigrapher Albert Rehm (1871-1949) in that month.<sup>42</sup> (Supplementary Fig. S10 reproduces Karo's photograph of C-1.) Another set made,

that the work was delayed for many months, perhaps because Rousopoulos was occupied with other work in the Museum, perhaps also because of fears such as those expressed by Svoronos ("Τὸ ἀστρολάβον τῶν Ἀντικυθήρων," *Νέον Ἄστυ* no. 163, May 23, 1902, p. 2) that the fragments might be destroyed in the process of cleaning.

40 Rousopoulos 1905.

41 Rousopoulos provides little detail. "Finkener's method" of cleaning antique bronzes, as described in Rathgen 1898, 108-120 = Rathgen 1905, 125-139, was an electrolytic process in which the object was immersed in a bath of potassium cyanide. Rathgen, however, recommends this method only for objects in which a good core of free metal survives, which was not the case with the Mechanism's fragments. Some surfaces of the fragments, e.g. the back face of Fragment C, show little evidence of cleaning in the early photographs, suggesting that Rousopoulos applied chemical cleaning only to certain areas of interest.

42 The set of prints that Karo sent to Rehm is preserved in Bayerische Staatsbibliothek Rehiana III/9. Karo's letter accompanying the photographs, dated, October 14, 1905, is in

reportedly, in 1918 shows fragments A, B, and C practically unchanged since 1905 (fragment D does not appear in this set), so we may conclude that Rousopoulos's conservation had come to a halt about the end of 1905.<sup>43</sup> (Supplementary Fig. S7, of A-2, is from this set.) The number of fragments had grown by this time through the separation of fused pieces of material. One such new fragment, a piece of inscribed plate now known as Fragment 19, was removed from Fragment A (leaving behind mirror-image impressions), and a photograph and transcription of it were published by Valerios Stais early in 1905 in a pamphlet on the finds from the Antikythera wreck.<sup>44</sup> Fragments 19 and 67 (a smaller piece of the same inscribed plate, also removed from A) are also shown in one of Karo's photographs. Transcriptions of text from other pieces detached from Fragments A and C, mostly identifiable among the present fragments, appear in Rehm's notes and in Theofanidis's publications.<sup>45</sup>

Rehmiana IV D. Biography of Rehm: Haffter 1950.

43 Rehm's prints of this set are also in Rehmiana III/9; they can be distinguished from Karo's by the different rulers that were photographed with the fragments. There was apparently no photograph of Fragment D in the new set. We tentatively identify them with a set mentioned by Price (1974, 11) whose negatives, bearing the date "IX 13/18", were preserved in the National Archeological Museum in his time, though unfortunately they cannot now be located. We base this identification on Price's statement (p. 12) that two photographs of Fragments A and C in Zinner 1943, which are from Rehm's prints, belong to the 1918 set. Since, however, Price mistakenly says that photographs from the 1918 set had previously appeared in Gunther 1932 (which actually reproduces part of Plate X of Svoronos 1903a/1903b) and Zinner 1931 (which has no photographs at all), caution is in order. Moreover, comparison of the 1905 set and the presumed 1918 set does not fully bear out Price's remark that the 1918 photographs "show extra detail revealed after a new cleaning"; some of the later set are indeed sharper than their 1905 counterparts but others are poorer if not entirely spoiled by overexposure, and there is no sign of intervening conservation work. The most noticeable difference in the fragments between the two sets is that some bits of material had broken off the rear face of Fragment A by the second set. Price had photographs of Rehm's full set of prints (negative strip in the Adler Planetarium collection), and in Price 1974, 23-26 he reproduced photographs of A-1 and C-1 from the Karo set and of A-2 and C-2 from the 1918 set.

44 Stais 1905, 18-23. The monograph is announced as a "new book" in the April 1905 issue of *Παναθήναια*, p. 64. Stais, incidentally, speaks of the conservation of the Mechanism's fragments as being still in progress, and expresses the expectation that more fused pieces of plate would be removed in due course.

45 Rehm's transcriptions of some of the detached fragments are in his 1906 *Notizbuch* in Rehmiana III/7; a copy (in another hand) of a somewhat more extensive version is in the file of Price's notes on the Mechanism's inscriptions at the Adler Planetarium. See also Theofanidis [1927-1930], "98"- "99" [correct pagination: 90-91]; 1934a, 144; and 1934b, 151.

Some of the fragments (probably A, B, and C) were on public display from at least as early as 1907 to just before the Second World War in the Rotunda of the Museum among other bronze artifacts from the Antikythera wreck (cases 237-244).<sup>46</sup> Ioannis Theofanidis studied them in the late 1920s and early 1930s, and his frustratingly inexact descriptions and line drawings, published in 1927 and 1934, are the only known evidence for their state at this period.<sup>47</sup> During the Second World War the fragments were in underground storage along with the rest of the Museum's collections.<sup>48</sup> In 1953 Ioannis Bakoulis, the head technician of the Museum, carried out a new course of conservation on them, which likely involved both chemical cleaning and physical removal of accretion layers.<sup>49</sup>

The condition of Fragments A, B, and C after the 1953 conservation is documented in photographs provided by the Museum that year to Derek de Solla Price, which he published several times between 1956 and 1974.<sup>50</sup> Compared to their 1905/1918 states, all three fragments have undergone visible alterations, some of which appear to be the result of accidental breakages (likely incurred during the wartime storage) rather than deliberate interventions by the conservator. Photographs taken by or for Price during his 1958 sojourn at the Museum show not only Fragments A, B, and C but also many other fragments; most of the larger ones among them can be identified among the present fragments by their shapes although the photographs are unfortunately not sharp enough to show much detail.<sup>51</sup> Some

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46 Stais 1907, 301-302 (= Stais 1910, 357); Baedeker 1908, 88; Theofanidis [1927-1930] "97" [correct pagination: 89]; Karo 1937, 133.

47 Theofanidis [1927-1930]; Theofanidis 1934a and 1934b.

48 Responding in a letter dated July 14, 1944 (Rehmiana IV A) to an application from Rehm to obtain casts of the fragments, Walther Wrede (1893-1990), first director of the German Archeological Institute in Athens, notified Rehm that all the Museum's antiquities including the Mechanism had been inaccessibly stored in underground locations since 1940. The Mechanism had probably been deposited, with the ceramics and other small objects, in wooden crates in the basement of the new wing of the Museum (Petrakos 1994, 87-90).

49 The new conservation is mentioned in "ΤΟ ΑΡΧΑΙΟΝ ΩΡΟΛΟΓΙΟΝ ΑΣΤΡΟΝΟΜΙΑΣ, ΜΙΑ ΑΝΑΚΟΙΝΩΣΙΣ ΤΟΥ ΑΡΧΑΙΟΛΟΓΙΚΟΥ ΜΟΥΣΕΙΟΥ", *Ἐλευθερία*, Sunday, January 11, 1959, p. 11. A previous article by Athena Kalogeropoulou in the same newspaper, "ΟΙ ΑΡΧΑΙΟΙ ΕΓΝΩΡΙΖΑΝ ΟΛΑ ΤΑ ΜΥΣΤΙΚΑ ΤΗΣ ΝΑΥΣΙΠΛΟΪΑΣ," *Ἐλευθερία*, Friday, January 9, 1959, p. 3, states that the fragments had not yet been installed in the new exhibits of the Museum by the beginning of 1959.

50 Price 1974, 12. The photographs are reproduced there on pp. 23-26, figs. 12, 15, 17a, 17c, 18a, and 19a.

51 Price's photograph collection is kept at the Adler Planetarium. Price worked on the fragments at the Museum in 1958, 1961, and 1972 (Price 1974, 12-13), but the first of these visits appears to have been the occasion of the great part of his physical examination of the fragments, including his collaboration with George Stamires on the inscriptions. The

of these fragments, like Fragment 19, are known to have been separated from A, B, or C during Rousopoulos's conservation. Of particular importance among this group is Fragment G (Supplementary Fig. S5), an inscribed plate fragment assembled from numerous pieces that had been separated from C-1. Others among the "new" fragments certainly broke off or were removed from the principal fragments after 1918. The flat boxes (some of them are cigar boxes) in which the fragments were stored may be seen, including a box containing crumb-sized bits which appears no longer to exist.<sup>52</sup>

Fragment D, which had apparently gone missing after 1905, was found again around 1972-1974.<sup>53</sup> Another substantial fragment not previously known, now called E, was discovered by Petros Kalligas in 1976 in the Museum's basement pottery storeroom (Y15), along with fragments of pottery, glass, and other small objects from the Antikythera wreck, and transferred to the bronzes storeroom.<sup>54</sup> In advance of the 2005 data-gathering of the Antikythera Mechanism Research Project, the inventory of known fragments was brought up to 82, including another major new discovery (Fragment F).<sup>55</sup> E and F were not formerly parts of one or other of the four fragments known in 1903, as documented in the photographs published in that year. Among the smaller fragments now designated by numbers 1 through 75, Fragments 19 through 30 and 39 through 44 are mostly identifiable in Price's 1958 photographs and appear to have been separated from one or another of the four "original" fragments (in particular A and C), while at least some of the rest may, like E and F, have lurked for decades among unidentified materials from the salvage of the wreck.

photographs in question can be dated to this visit by the use of one of them as the cover image on the June 1959 issue of *Scientific American* in which Price 1959 appeared. Oddly, Price 1974, 47 speaks of the existence of only "some fifteen small fragments, most of them being scraps of inscribed plate...", though his photographs show many more than that. We note here that a pair of negatives showing both sides of Fragments A, B, and C, photographed by Emile Séraf is now in the collection of the Athens Department of the Deutsches Archäologisches Institut; these cannot be precisely dated but show the fragments in approximately the same state as Price's photographs, while being of distinctly higher quality.

52 This box was the source of the samples used for the metallurgical analyses made shortly after Price's 1958 visit, which are reported in Price 1974, 63-66; see also below, section 2.4. The fragments were still stored in the cigar boxes when they were seen by Arthur C. Clarke in 1965 (Clarke 1975, 115 = Clarke 1977, 190; Clarke 2001).

53 Price 1974, 13.

54 Personal communication from Mary Zafeiropoulou.

55 The discovery of Fragment F and several small fragments not known to Price in the Museum's bronze storeroom is due to Mary Zafeiropoulou, who also assigned the now standard letters and numbers to all the fragments beyond A-E; see Zafeiropoulou 2012a and 2012b, 11.

Despite Price's dangerous wish, expressed in *Gears from the Greeks*, that the fragments should be subjected to yet another round of cleaning and separation,<sup>56</sup> the principal fragments, A, B, and C have not experienced much alteration since 1955, and scarcely at all since 1990, in which year they were photographed by M. T. Wright.<sup>57</sup> (Supplementary Figs. S1 - S4 show the inscription-bearing faces of A, B, and C as they were in 2005.) According to former conservators of the Museum, Fragments A, B, C, D, and G as well as some of the smaller inscribed fragments have been conserved from time to time when it was considered necessary.<sup>58</sup> The most notable changes visible between 1955 and 1990 are, on Fragment A, the reattachment of a small piece that had broken off it between 1918 and 1955, and on Fragment C, the reattachment of another small piece that had broken off between 1953 and 1958.<sup>59</sup>

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56 Price 1974, 47. Two decades earlier, before he had seen the fragments in person though apparently after Bakoulis's work, Price applied unsuccessfully to the Greek government to have them sent to the British Museum for conservation, as he reports, somewhat intemperately, in Price 1956, 33 n. 18.

57 Personal communication. Wright's photographs of Fragments A, B, and C (both sides) are reproduced in Wright 2007 (as well as, variously, in several of his other papers).

58 Personal communication from Mary Zafeiropoulou.

59 The reattachment of the piece from Fragment A appears to have occurred between 1971-1972 (the date of Karakalos's radiographs, which do not show the piece) and 1980 (the date of the television series *Arthur C. Clarke's Mysterious World*, episode 3 of which featured Price's work on the Mechanism including a brief view of Fragment A in which the piece is just visible). The bit broken off the bottom of Fragment C can be seen lying next to the rest of the fragment in some of Price's unpublished photographs from 1958. This damage had happened since the photographs made for Price in 1953, and it seems to have been repaired during Price's visit. The fragments in their present condition show signs of having suffered other breakages that were probably repaired immediately. Researchers have repeatedly remarked on the ease with which the fragments' chalk-like material breaks or crumbles with handling; see for example Rediadis's remarks quoted above, Theofanidis [1927-1930], "97" [correct pagination: 89]; Price 1974, 46; Bromley 1990, 643; and Marchant 2008, 179-181.

## 2.2 Previous transcriptions

Before the 2005 data gathering, the only means of reading the Mechanism's inscriptions was autopsy, with only small assistance from conventional photography.<sup>60</sup> Conventional radiographs did not show inscribed letters at all; the linear tomography of Wright, Bromley, and Magou was just sensitive enough to reveal some letters concealed within Fragment C but not clear enough to enable them to be read.<sup>61</sup> CT and PTM imaging have now effectively superseded direct inspection. Earlier published and unpublished transcriptions nevertheless continue to be useful as evidence for the history of the fragments and potentially as witnesses of text that has been lost or become less legible as a consequence of accidental damage and essential conservation work. We here list the transcriptions up to the 1970s that we are aware of. A detailed survey of earlier transcriptions of the individual inscriptions will be provided in each of the remaining papers in the present series.

Transcriptions in newspapers, 1902: *Σκρίπ* May 22, *Νέον Άστυ* May 22 and 23, *Έστία* May 22, *Τò Άστυ* May 23 and 24, *Ελεύθερος Τύπος* May 24

Back Plate Inscription (A) and Back Cover Inscription (B), readings communicated to reporters by Vyzantinos (?), Wilhelm, and Svoronos.

Svoronos 1903a, 46/1903b, 45-46

Back Plate Inscription (A) and Back Cover Inscription (B), credited to Svoronos with contributions by Wilhelm.

Stais 1905, 22

Back Cover Inscription (19).

Rehm 1905, 18-21

Parapegma Inscription (C), and supplements to the 1903 Svoronos and 1905 Stais transcriptions of the Back Cover Inscription (B, 19).

Rehm 1906a, 86-87

Front Dial Inscriptions (C), Front Cover Inscriptions (various small fragments, some of which are now parts of G).<sup>62</sup>

60 Most of the photographs that Rehm and Price worked with are unsatisfactory for reading the inscriptions, and the photographs that appeared in publications up to and including Price 1974 are generally illegible.

61 Wright, Bromley, & Magou 1995, 542.

62 We suspect that Rehm made other transcriptions that have not yet been located. The copies of small fragments in the "Notizbuch" are labelled with Greek letters running from iota through sigma, implying that there were eight previous texts. The Back Cover Inscription on B,



Rehm 1906b, 3

Parapegma Inscription (C).

Rados 1910, 10-11 and 34

Back Plate Inscription (A) and Back Cover Inscription (B) reproduced from Svoronos 1903a, Back Cover Inscription (19) reproduced, with a typographic error, from Stais 1905, and Front Dial Inscriptions (C) from Karo's report of Rehm's researches.

Theofanidis [1927-1930], "98"- "99" [correct pagination: 90-91]

Front Cover Inscription (small fragment, now part of G), Parapegma Inscription (C), Back Dial Inscriptions (24), Back Plate Inscription (A, 24), and Back Cover Inscription (B, 19), in part credited to Vasileios Leonardos.<sup>63</sup>

Theofanidis 1934a, 141-146

Repeats transcriptions from Theofanidis [1927-1930].

Price 1959, 64-65

Front Dial Inscriptions (C), Parapegma Inscription (C), Back Dial Inscriptions (A, B). Price credits the transcriptions to the epigrapher George Stamires.

Price 1974, 18 and 46-51

Front Cover Inscription (G), Front Dial Inscriptions (C), Parapegma Inscription (C, 20, 22, 28), Back Plate Inscription (A), Back Cover Inscription (A, B, 19). Again Price attributes the transcriptions, at least in large part, to Stamires.<sup>64</sup>

the Back Plate Inscription on A, the Back Cover Inscription on 19, the Parapegma Inscription on C, and the month name on C would account for five, and it is plausible that Rehm also noticed the Back Cover Inscription on A which is not mentioned in published scholarship before Theofanidis [1927-1930] "98" [correct pagination: 90], who mentions "a multitude of pressed-on letters absolutely incapable of being read". The isolated letters "T" on Fragment C and "H" (actually the four-stroke form of xi, "Ξ", read sideways) on Fragment A, mentioned by Rediadis in Svoronos 1903a, 45-47 and 1903b, 45-46, would complete the tally.

<sup>63</sup> For Leonardos see note 69 below.

<sup>64</sup> Stamires left academic life in 1961 after his appointment as a research assistant to B.D. Meritt at the Institute for Advanced Study, Princeton, came to an end, so it is doubtful whether his collaboration with Price continued long after 1958. Price had definitely lost all contact with Stamires by 1973 (letter of Price to B.D. Meritt, October 3, 1973, Meritt papers, American Philosophical Society). Price's file of notes and transcriptions of the inscriptions, preserved at the Adler Planetarium Chicago, contains pages in more than one hand, but it is not clear whether any of them were written by Stamires.

Price, unpublished file of transcriptions and notes at Adler Planetarium

In addition to preliminary versions of the transcriptions published in Price 1974, these undated notes include some of the inscribed small fragments that were not included in that work.

Antikythera Mechanism Research Project: Freeth et al. 2006, Supplementary Information 5 and 8-10

Front Cover Inscription (G), Back Dial Inscriptions (A, B, E, F, 24), Back Plate Inscription (A, E, F), Back Cover Inscription (A, B, E, 19).

Freeth, Jones, Steele, & Bitsakis 2008, Supplementary Notes [revised 2011], 10-11, 19-20, 25-28, and 40

Back Dial Inscriptions (A, B, E, F, 24).

Zafeiropoulou 2012a, 245

Front Cover Inscription (G), credited to A. Tselikas.

Freeth & Jones 2012, Section 2.3.2 and Fig. 4

Back Cover Inscription (i 16-26), transcription, and Parapegma and Front Dial Inscriptions, transcription incorporating some restored text, uncredited but based on preliminary work towards the editions in the papers IAM 3 and IAM 5 of the present series.

Freeth 2014, Supplementary note S2 with Figs. S5 and S13

Back Plate Inscription, transcription by C. Crowther with T. Freeth, and Saros Dial Inscriptions by T. Freeth.

## 2.3 Previous paleographic appraisals

The first scholars to examine the inscriptions were at least as interested in dating them according to their letter forms as in reading them. A date of manufacture for the Mechanism would establish a *terminus post quem* for the date of the shipwreck, which was a subject of vigorous debate in 1902. When Vyzantinos spoke to reporters on May 21 after an initial examination of the just-discovered fragments (Σκριπ and Νέον Άστυ, May 22), he said that the antiquities from the shipwreck belonged to the interval between 150 B.C. and A.D. 200, a cautious assessment that probably reflected the views of most of the Greek archeologists who had studied the materials.<sup>65</sup> For months, however, Svoronos had been vocally maintaining that the wreck dated from the time of Constantine, that is, the 4<sup>th</sup> century A.D.<sup>66</sup> Hence when Wilhelm visited the Museum on May 22 at the archeologists' invitation to examine the inscriptions, it is not surprising that Svoronos chose to be present and to involve himself. The earlier reports from that day have Wilhelm making a preliminary statement giving his opinion that the writing dated to the 1<sup>st</sup> century B.C.; but later that day Svoronos spoke to the reporters at greater length, saying that the letter forms were characteristic of the second or 1<sup>st</sup> century B.C., but that the serifs pointed to a later date, as late as the 2<sup>nd</sup> or 3<sup>rd</sup> century A.D.<sup>67</sup> It is hard to resist a suspicion that Svoronos, whose epigraphical experience was chiefly with coins, allowed his judgment to be biased by his conviction that the wreck was from the late Roman Empire. In any case both Wilhelm and Svoronos were basing their datings on fewer than fifty mirror-image letters of the Back Cover Inscription that they were able to make out on Fragment B.<sup>68</sup>

The situation had scarcely changed by the end of 1902. In response to Svoronos's repeated

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65 The report in *Νέον Άστυ* on the same day has Vyzantinos assigning this date range specifically to the Mechanism, but this was probably not an attempt at paleographical assessment but rather an inference from the archeological context.

66 See e.g. his address reported in *Τὸ Άστυ* 3869, August 16, 1901, p. 2.

67 According to *Τὸ Άστυ*, May 23, Svoronos said that the serifs implied a first or second century AD date, while *Νέον Άστυ*, May 23, reports him as saying that the date could be as late as the third century.

68 Wilhelm's involvement seems to have been slight following his first inspection of Fragments A and B on May 22, 1902. A week after his visit, a report "Τὸ ἀνεξιγήτητον μηχανήμα τῶν Ἀντικυθῆρων", *Τὸ Άστυ*, no. 4147, May 29, 1902, p. 1 states that once the fragments had been cleaned, the reading of the inscriptions would be entrusted to the "expert epigrapher" Vasileios Leonardos (1857-1930), the director of the Epigraphic Museum, calling him "the only Ephor of Antiquities competent for this". After this assertion of territoriality, Leonardos vanishes from the story of the Mechanism until the 1920s, when he read at least one of the inscriptions for Theofanidis (Theofanidis [1927-1930], "99" [correct pagination: 91]). Biography of Leonardos in *Μεγάλη Ἑλληνικὴ Ἐγκυκλοπαίδεια* 15, 937-938.

public airings of his theories concerning the wreck (in addition to the late dating, Svoronos maintained that the ship was heading from Argos to Constantinople when it sank), Valerios Stais published a lengthy rebuttal in *Τὸ Ἄστυ*, December 13 and 14. In the first instalment he asserts that the letter forms of the Mechanism's inscriptions, being typical of the third and second centuries BC, would be difficult to date later than the 1<sup>st</sup> century B.C., and "*impossible, completely impossible*" (his emphasis) to assign to the 4<sup>th</sup> century A.D. The anonymous article on the wreck in the 1902 volume of *Ἐφημερίς Ἀρχαιολογική* uses almost identical words to state that the writing would be difficult to date later than the middle of the 1<sup>st</sup> century B.C.<sup>69</sup>

Thus Svoronos was more or less on his own in opposition to the leading Greek archeologists on both the broad question of the provenance and date of the wreck and on the dating of the Mechanism. Despite its appearance of being an official publication of the wreck and the salvaged antiquities, his 1903 monograph is really a "minority report". Here, embedded in Rediadis's section on the Mechanism, we find Svoronos asserting that the inscriptions could be dated paleographically as late as the time of the emperors Maximus and Gordian (A.D. 235-244).

Up to this point all the appraisals had been based on the rather meager readings that had been obtained from the mirror-text Back Cover Inscription on Fragment B and a handful of letters —no entire words— of the Back Plate Inscription on A, before either fragment had been subjected to cleaning and separation of accreted layers of plate. One outcome of Rousopoulos's work was the removal of Fragment 19, the largest surviving piece of the original plate bearing the Back Cover Inscription, from Fragment A. The inscribed face of Fragment 19 was in much better condition than any part of the inscriptions that had been seen hitherto, and in 1905 Stais based on it the first detailed discussion of the letter forms and their dating, though his concern remained to establish a Hellenistic date and rule out a late Roman one rather than to try to narrow down the dating within the Hellenistic period. Thus he notes the use of isosceles A with horizontal middle hasta, the rectilinear E and Σ, and the forms of Π and Ω, all of which, he says, argue for a date within the last three centuries BC.

In his first unpublished essay on the Mechanism, written in late 1905, Rehm does not discuss the paleography in detail, but expresses his comfort with an Augustan (i.e. late 1<sup>st</sup> century B.C.) date for the letter forms.<sup>70</sup> This dating was influenced, however, by an extra-paleographical consideration, namely Rehm's belief that the Egyptian month name that he read on Fragment C's exposed dial pertained to the reformed Egyptian calendar, introduced during the reign of Augustus. Rehm did not know that this calendar dial was a removable ring designed to be adjustable in position relative to the solar year, from which

69 [Anonymous] 1902, 172. For the authors of this article see note 35 above.

70 Rehm 1905, 30.

it follows that the *unreformed* calendar was intended. (No conclusions can be drawn from this concerning the Mechanism's date since the unreformed calendar continued to be used for astronomical calculations long after it ceased to be the civil calendar in Egypt.)<sup>71</sup> In his second essay, from late 1906, Rehm characterizes the writing as typical of the first century BC, singling out the tendency of the top and bottom hastae of sigma to be not quite parallel and that of the right vertical hasta of pi to be shorter than the left hasta.<sup>72</sup> In the margin Rehm added the argument from the Egyptian month for a *terminus post quem*, this time giving the specific year 26 B.C. as the inaugural year of the reformed Egyptian calendar.

Rados assigns the writing to the 1<sup>st</sup> century B.C., citing Stais's monograph, though in fact Stais had only given that century as the latest possible.<sup>73</sup>

Theofanidis writes, with reference to the Back Plate Inscription on Fragment A and the Parapegma Inscription on C, that the style of letter forms is characteristic of the 2<sup>nd</sup> century B.C.<sup>74</sup> Since this is an estimate different from any that had appeared in print earlier, we suppose that he got it from Leonardos, who he says read the Parapegma Inscription for him.

Although Price was assisted by Stamires for the reading of the inscriptions, he resorted for their paleographical dating to B.D. Meritt, whose appraisal was made from photographs. According to Price's 1959 summary, Meritt judged the writing as belonging to the 1<sup>st</sup> century

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71 We comment here on Price's often cited dating of the Mechanism to about 82 B.C. (Price 1959, 65), later revised to about 87 B.C. (Price 1974, 19). Price derived this dating by a circuitous argument from a "fiducial mark" that he discovered on the frame plate of Fragment C just outside the calendar dial, and that he supposed to indicate an epoch alignment for the beginning of an Egyptian calendar month. The presence of a crack running along the mark has raised doubts about whether it is a deliberate engraving (Bromley 1990, 651-652). If it does mark an epoch position for the ring, it stands to reason that the mark signifies an epoch alignment of a solar longitude of approximately Libra 18° with the *beginning* of the Egyptian year (Thoth 1), not the beginning of the calendar's second month (Phaophi 1) as required for Price's dating. This would have been valid close to the end of the 3<sup>rd</sup> century B.C., say around 210 B.C. (For a similar argument see Carman & Evans 2014, 760-763.) Such an epoch would provide us with a *terminus post quem* for the date of the Mechanism's manufacture.

72 Rehm 1906b, 8. Lippold 1923, 250 n. 6, quotes a private communication from Rehm to the same effect: "Die Schrift — das einzige Datierungsmittel— setze ich ins 1. Jahrh. v. Chr.... also frühestens Zeit des Posidonios. *Nach* Chr. Geb. herunterzugehen wird man auch keinen Anlaß haben". Rehm seems by this time to have abandoned, or forgotten, his inference of a post-30 B.C. date from the Egyptian month name, though he had previously communicated it to Georg Karo, through whom it appeared in print; see Leroux 1913, 102, and Karo 1948, 181.

73 Rados 1910, 24.

74 Theofanidis [1927-1930] "98"-"99" (correct pagination: 90-91).

B.C.; it “could hardly be older than 100 B.C. nor younger than the time of Christ”.<sup>75</sup> In 1974 Price reported Meritt’s view slightly differently, and with some detail:

“The letter forms are, in the opinion of Professor Benjamin Meritt, characteristic of the first century B.C., or more loosely, of Augustan times. For example, the left vertical of Π is much longer than the right; the vertical strokes of M and the horizontal ones of Σ are not parallel. There are tiny serifs at the end of each stroke”.

With access to the imaging of the inscriptions made possible by the 2005 data-gathering, H. Kritzas has concluded that the possible date range for the inscriptions is:<sup>76</sup>

“the second half of the 2<sup>nd</sup> Century BC and the beginning of the 1<sup>st</sup> Century BC, with an uncertainty of about one generation (50 years). Dates around 150 BC to 100 BC are a plausible range”.

Characteristics of attested forms of twelve letters, which Kritzas associates with various typical date ranges, are adduced to support this dating.<sup>77</sup> Subsequently, C. Crowther has offered several qualifications of Kritzas’s comments on individual letter forms, and given as a general assessment that the possible range for the Mechanism’s inscriptions extends from the late third century through the early 1<sup>st</sup> century B.C., “with a preference for the earlier half of this period”.<sup>78</sup> And most recently, P. Iversen considers that the letter forms allow for a dating anywhere from slightly before 200 BC to slightly after A.D. 50.<sup>79</sup>

Among the various people who have offered paleographical datings of the inscriptions, Wilhelm, Leonardos, Meritt, Kritzas, Crowther, and Iversen all qualify as experienced and competent epigraphers, and Rehm, though early in his epigraphical career, had already acquired considerable experience from his work as epigrapher for the German excavations in Asia Minor; on the other hand, we may discount Svoronos, whose outlier opinion was evidently neither expert nor unbiased. Every estimate except Svoronos’s has fallen within a range from the late 3<sup>rd</sup> century B.C. to the 1<sup>st</sup> century A.D. (with the later part of this range now discounted because we know that the Mechanism cannot be later than the shipwreck), but when it comes to determining tighter bounds, there is no consensus.

That there should be divergences among datings by experts is no cause for surprise, since letter forms are a reliable basis for dating inscriptions only when the inscription has a

75 Price 1959, 61.

76 Freeth et al. 2006, Supplementary Information 7.

77 See also Hannah 2008, 31 for endorsement of Kritzas’s dating.

78 Quoted in Freeth 2014, Supplementary Note S2.

79 Iversen (forthcoming).

known provenance and can be compared to numerous other datable inscriptions from the same place, conditions that are not satisfied for the Antikythera Mechanism; in general, in the words of A.G. Woodhead, “this criterion [*scil.* letter forms], so often used as a first resort, is much better left as a final refuge; its evidence is far less precise and secure than is popularly supposed”.<sup>80</sup> Additionally, we are dealing with inscriptions made in the style of Hellenistic inscriptions on stone, but on a different medium, with different tools, and at a much smaller size than the typical range of contemporary stone inscriptions.<sup>81</sup> Hence while their paleography establishes with high probability that they were inscribed at some point between the late 3<sup>rd</sup> century B.C. and the date of the wreck, we cannot appeal to the letter forms to narrow this interval.

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80 Woodhead 1967, 62; see also McLean 2002, 42-45; Tracy 2009; Iversen (forthcoming). Tracy gives examples of datings that have proved to be many decades in error; see also Tracy 2000, 71, for an instance in which two separately published fragments of inscription, one of them exactly dated by its contents to 191 B.C. and the other paleographically dated to c. 280 B.C., proved to be adjoining pieces of the same inscription.

81 For example, letter heights in Attic decrees are typically 5-9 mm (Tracy 1970, 324 n. 26), while inventories and leases can have letter heights around 3-4 mm (McLean 2002, 43). By contrast the largest lettering of the Mechanism, in the Parapegma Inscription, keeps within the range 2.3-3.0 mm, and the smallest lettering, on the dials, is barely taller than 1 mm.

## 2.4 General observations on the inscriptions

Although we conventionally speak of the Antikythera Mechanism as having consisted of bronze and wood, there is some question about the precise composition of the alloy or alloys employed, in particular with respect to the inscribed plates. In 1910 Rediadis asserted that the mechanical components of the Mechanism were made of copper (έκ χάλκου), citing an analysis by the chemist A.K. Dambergis, which was, however, of other antiquities from the Antikythera wreck, not the Mechanism.<sup>82</sup> Price obtained chemical and spectrographic analyses of small samples from the previously mentioned box of crumb-sized bits that was stored with the Mechanism's fragments in 1958; it is likely that the contents of this box were chiefly bits broken off the inscribed plates and the accretion layers. These analyses indicated a composition of copper with a small amount (1–10%) of tin but no other metals in significant quantity.<sup>83</sup> On the other hand, recent nondestructive (surface) chemical analyses of small inscription fragments conducted by P. Mitropoulos in the Electronic Microscopy and Microanalysis facilities of the Department of Geology and Geoenvironment, University of Athens, found, in addition to an alloy comprising 85% copper and 15% tin, two other pewter-like alloys in which tin was the predominant component, with smaller amounts of copper and lead.<sup>84</sup> Plate having these latter compositions would have been very soft, so suitable for engraving though not for components requiring rigidity.<sup>85</sup>

The lettering appears to have been engraved using a burin, a tool with a sharp, hard metal point at one end and a rounded handle at the other which is pushed by the engraver's hand.<sup>86</sup> Unlike a tracer or chisel, which is hammered into the plate to make grooves, a burin forms grooves by removing metal, not displacing it; CT cross sections of the Mechanism's lettering show no ridges alongside the grooves (Fig. 2.1).<sup>87</sup>

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82 Rediadis 1910, 164; Dambergis 1906.

83 Price 1974, 63–66, giving reports by E.R. Caley (chemical analysis) and C.S. Smith (spectrographic analysis). Caley remarks on the absence of lead as a likely indicator of a date of manufacture earlier than the 1st century B.C. However, the presence of lead in bronzes in the later Hellenistic period was largely motivated by its enhancement of the casting properties of the alloy, whereas leaded bronze is less suited to cold working; hence unleaded bronze continued to be used for objects fashioned from sheet bronze (Craddock 1977, 111 and 115).

84 Zafeiropoulou 2012a, 243.

85 Wright 2011, 8–9.

86 M.T. Wright, by personal communication.

87 Maryon 1949, 115–118.



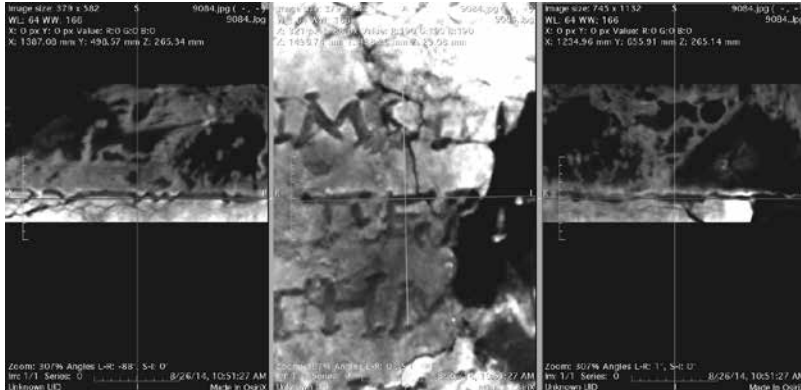


Figure 2.1: *CT views of engraved lettering in Fragment E. (left) Vertical cross section in a plane perpendicular to the plate. (center) Cross section parallel to the plate and near its surface. (right) Horizontal cross section in a plane perpendicular to the plate. This part of the plate has a layer of accreted matter against it, whose surface follows the outlines of the engraving*  
*(Images: Antikythera Mechanism Research Project)*

The inscriptions, when viewed directly, give an impression of neatness and regularity, which is largely due to their tiny size (Fig. 2.2). Under magnification, the sizes, line and letter spacing, and shapes of the letters prove to be rather irregular, though the engraver has clearly worked hard to imitate the appearance of serified lettering on stone (Fig. 2.3). Correct syllabic word division has been respected at line-ends. There is no punctuation, and numerals as a rule are not marked as such by an overstroke (an exception in the Back Cover Inscription, II.3) but are usually preceded and followed by modest *vacats*. *Vacats* also occasionally separate words, following no obvious principle.



Figure 2.2: *Fragment 19, a piece of the Back Cover Inscription plate, at actual size, image from PTM ak1a with specular enhancement*  
*(Image: Antikythera Mechanism Research Project)*

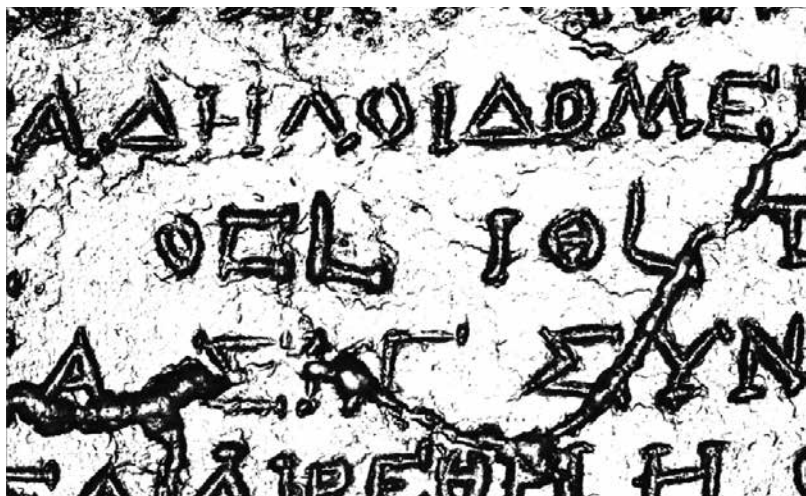


Figure 2.3: *Detail of Fragment 19, image from PTM ak1a with specular enhancement*  
(Images: Antikythera Mechanism Research Project)

The variable state of preservation of the inscriptions is an impediment to comparing the lettering from one part of the Mechanism to another. We have good specimens of the Parapegma Inscription on Fragment C-1, and of the Back Cover Inscription on Fragment 19 and inside Fragment E (viewable only by CT). The best specimens of the Back Plate Inscription are in Fragment F (viewable by CT) in addition to some well preserved letters on Fragment A-2. For the most part, the remains of the Front Cover Inscription are badly corroded, and probably the best specimen of its lettering is in the offsets on Fragment 21. Of the inscriptions on the dial scales, those on the front dial are mostly rather unclear, those of the upper back dials very badly preserved indeed, but there are some good specimens of the eclipse glyphs on the Saros Dial. Some differences in the general look of the lettering are apparent, in particular a tendency for verticals in parts of the Front Cover Inscription and the Back Plate Inscription to slope slightly, in contrast to the greater uprightness seen elsewhere. Such diversity is perhaps not enough in itself to imply that more than one engraver was at work.

Letter forms can be variable, even within a single inscription. The slightly diverging top and bottom strokes of the sigmas have been remarked on for their bearing on the paleographical dating; but one also frequently finds sigmas with parallel top and bottom strokes (e.g. both forms in Fig. 2.3, Back Cover Inscription II.20). Omicron is sometimes small and elevated above the baseline, sometimes a larger loop occupying the full normal letter height. The middle “vee” strokes of mu sometimes touch at the baseline, sometimes above it, and the slope of the first and last strokes from the vertical is also variable. These may be accidental variations arising from the handling of the engraving tool in making very small letters. There are also some instances of truly distinct letter forms:

- In the Back Cover Inscription, theta is always a narrow oval with a cross stroke;

in the other inscriptions, it is always a near-circular loop with a central dot. This consistent distinction of forms would be hard to explain unless the Back Cover Inscription was engraved by a different person from the other inscriptions.

- In the Front Cover Inscription, xi occurs in two forms, either with three horizontal strokes ( $\Xi$ ) or with three horizontals crossed centrally by a vertical stroke ( $\text{Ξ}$ ). The four-stroke version seems to have been used in this inscription specially for numerals, and it also occurs among the index letters on the Zodiac Scale.
- The normal form of omega has a large loop open at the bottom ( $\Omega$ ); but in the Back Plate Inscription (line 4) there is a likely instance of the W-shaped cursive omega ( $\omega$ ).

Numerals are in the Ionian (alphabetic) notation; there are no instances of fractions. The symbol representing 6 (often wrongly called “stigma”, though actually a form of digamma) comprises three straight strokes like an E without its middle stroke. A special symbol employed as an index letter in the Back Plate Inscription (line 29) may be a modified alpha standing for 1000. The L-shaped symbol for έτος (“year”) occurs in the scale inscriptions of the Metonic and Games Dials as well as in the Back Cover Inscription (II.19, where its resolution is -ετηρίς, “period of years”). The symbol for ώρα (“hour”), comprising a cursive omega crossed by a vertically elongated rho, occurs in the eclipse glyphs of the Saros Dial.

Definite or probable instances of errors committed by the engraver include the following:

- Parapegma Inscription: PP2 col. iii line 5 έπιτέλλει should have been the second last word
- Back Plate Inscription: 8 the line was initially begun too far to the left (corrected); 10 θραικιάν for θραικίας; 14-15 μεγάλην for μεγάλοι; 18 the index letter sigma should have been first; overstrokes seem to have been omitted over some letters in the index letter lines
- Back Cover Inscription: I.19 Αφροδίτη for Αφροδίτης; II.3 όλη for όλη; II.5 στιγμήον for στιγμήα (corrected)

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## References

- [Anonymous] (1902), "Τὰ εὐρήματα τοῦ ναυαγίου τῶν Ἀντικυθήρων", *Ἐφημερίς Ἀρχαιολογική* 1902: cols. 145-173 and plates 7-17.
- [Anonymous] (1939?), *Περικλῆς, Δ. Πεδιάδης. Βιογραφικὰ σημεῖωματα καὶ βιβλιογραφία*.
- Baedeker, K. (1908), *Griechenland: Handbuch für Reisende*. 5th edition. Leipzig.
- Bromley, A.G. (1990), "Observations of the Antikythera Mechanism", *Antiquarian Horology* 18: 641-652.
- Carman, C.C., Evans, J. (2014), "On the Epoch of the Antikythera Mechanism and its Eclipse Predictor", *Archive for History of Exact Sciences* 68: 693-774.
- Clarke, A.C. (1975), "Technology and the Limits of Knowledge", *Technology and the Frontiers of Knowledge: The Frank Nelson Doubleday Lectures 1972-1973*. New York, 111-134.
- Clarke, A.C. (1977), *The View from Serendip*. New York.
- Clarke, A.C. (2001), "Asking about Antikythera", *Astronomy & Geophysics* 42: 2.9.
- Craddock, P.T. (1977), "The Composition of the Copper Alloys used by the Greek, Etruscan and Roman Civilisations. 2. The Archaic, Classical and Hellenistic Greeks", *Journal of Archaeological Science* 4: 103-123.
- Dambergis, A.K. (1906), "Ἐξαγόμενα χημικῶν ἐξετάσεων ἀρχαιοτήτων τινῶν", *Ἄρμονία* 1906: 182-183.
- Fragkou, V. (2010a), *Ο μηχανισμός των Αντικυθήρων: Ιστορική Αναδρομή και Αστρονομικές Προεκτάσεις*. Thesis, Aristotle University of Thessaloniki, Department of Physics, Section of Astrophysics, Astronomy, and Mechanics. Thessaloniki. [http://www.astro.auth.gr/documents/diplomas/2010\\_Fragkou-Antikythera-gr.pdf](http://www.astro.auth.gr/documents/diplomas/2010_Fragkou-Antikythera-gr.pdf)
- Fragkou, V. (2010b), "The Antikythera Mechanism: Historical Reference and Astronomical Extensions", Thesis, Aristotle University of Thessaloniki, Department of Physics, Section of Astrophysics, Astronomy, and Mechanics. Thessaloniki. [http://www.astro.auth.gr/documents/diplomas/2010\\_Fragkou-Antikythera-en.pdf](http://www.astro.auth.gr/documents/diplomas/2010_Fragkou-Antikythera-en.pdf)
- Freeth, T. (2014), "Eclipse Prediction on the Antikythera Mechanism." *PLoS One (Public Library of Science)* 9.7.e103275. <http://dx.plos.org/10.1371/journal.pone.0103275>
- Freeth, T., Bitsakis, Y., Moussas, X., Seiradakis, J.H., Tselikas, A., Mangou, H., Zafeiropoulou, M., Hadland, R., Bate, D., Ramsey, A., Allen, M., Crawley, A., Hockley, P., Malzbender, T., Gelb, D., Ambrisco, W., Edmunds, M.G. (2006), "Decoding the ancient Greek astronomical calculator known as the Antikythera Mechanism", *Nature* 444: 587-591. <http://www.nature.com/nature/journal/v444/n7119/extref/nature05357-s1.pdf>
- Freeth, T., Jones, A., Steele, J.M., Bitsakis, Y. (2008), "Calendars with Olympiad display and eclipse prediction on the Antikythera Mechanism", *Nature* 454: 614-617. Supplementary Notes (amended June 2, 2011), <http://www.nature.com/nature/journal/v454/n7204/extref/nature07130-s1.pdf>.
- Freeth, T., Jones, A. (2012), "The Cosmos in the Antikythera Mechanism", *ISAW Papers* 4, <http://dlib.nyu.edu/awdl/isaw/isaw-papers/4/>.
- Gunther, R.T. (1932), *The Astrolabes of the World*. 2 vols. Oxford.
- Haffter, H. 1950. "Albert Rehm." *Gnomon* 22, 315-318.

- Hannah, R. (2008), *Time in Antiquity*. London.
- Iversen, P. (forthcoming), *The Antikythera Mechanism, Rhodes and Epeiros*.
- [Karo, G.] (1937), *Athen und Umgebung*. Grieben Reisenführer Bd. 12. Berlin.
- Karo, G. (1948), "Art Salvaged from the Sea": *Archaeology* 1: 179-185.
- Leroux, G. (1913), *Lagynos. Recherches sur la céramique et l'art ornemental hellénistiques*. Paris.
- Lippold, G. (1923), *Kopien und Umbildungen griechischer Statuen*. Munich.
- McLean, B. (2002), *An Introduction to Greek Epigraphy of the Hellenistic and Roman Periods from Alexander the Great down to the Reign of Constantine (323 B.C.-A.D. 337)*. Ann Arbor.
- Marchant, J. (2008), *Decoding the Heavens*. London.
- Maryon, H. (1949), "Metal Working in the Ancient World", *American Journal of Archaeology* 53: 93-125.
- Μέγα Ἑλληνικὸν Βιογραφικὸν Λεξικόν. 5 vols. Athens, 1958-1962.
- Μεγάλη Ἑλληνική Ἐγκυκλοπαίδεια. 2nd ed. 22 vols. and 4 supplement vols. Athens, 1956-1965.
- Nikoli, M. (2012), *Οι πρώτες αναφορές στην ανακάλυψη του ναυαγίου και του Μηχανισμού των Αντικυθήρων*. Thesis, Aristotle University of Thessaloniki, Department of Physics, Section of Astrophysics, Astronomy, and Mechanics. Thessaloniki. [http://www.astro.auth.gr/documents/diplomas/2012\\_Nikoli-Diploma-gr.pdf/](http://www.astro.auth.gr/documents/diplomas/2012_Nikoli-Diploma-gr.pdf/)
- Oikonomos, G. (1922), "Βαλέριος Ν. Στάης (1857-1923)", *Αρχαιολογική Ἐφημερίς* 1922 [published 1923]: 113-116.
- Petrakos, V. (1991), "Ο Βαλέριος Στάης στὰ Ἀντικύθηρα", *Ἡ ἐν Αθήναις Ἀρχαιολογική Ἐταιρεία, Ενημερωτικὸ Δελτίο* 14: 19-22.
- Petrakos, V. (1994), "Τὰ Αρχαία της Ελλάδος κατὰ τον πόλεμο 1940-1944", *Ο Μέντωρ* 7 (31): 69-185.
- Petrakos, V. (2011), *Ο ἐν Αθήναις Ἀρχαιολογική Ἐταιρεία. Οἱ ἀρχαιολόγοι καὶ οἱ ἀνασκαφές*. Athens.
- Petrakos, V. (2013), *Πρόχειρον Ἀρχαιολογικόν 1828-2012*. 2 vols. Athens.
- Petrocheilos, I. (1992), *Βαλέριος Ν. Στάης*. Athens.
- Price, D. (1956), "Clockwork Before the Clock. Conclusion of an article based on a lecture before a joint meeting of the British Horological Institute and the Antiquarian Horological Society", *Horological Journal*, January 1956: 31-35 (First part of the article in the December 1955:810-814).
- Price, D. (1959), "An Ancient Greek Computer" *Scientific American* June 1959: 60-67.
- Price, D. (1974), *Gears from the Greeks*. Transactions of the American Philosophical Society N.S. 64.7.
- Rados, K. (1910), *Ναυτικαὶ καὶ Ἀρχαιολογικαὶ Σελίδες. Περὶ τῶν Θησαυρῶν τῶν Ἀντικυθήρων*. Athens.
- Rathgen, F. (1898), *Die Konservierung von Alterthumsfunden*. Berlin.
- Rathgen, F. (1905), *The Preservation of Antiquities: A Handbook for Curators*, trans. G.A. Auden and H.A. Auden. Cambridge.
- Rediadis, P. (1903), "Ἀρχαιολογία. Ὁ ἀστρόλαβος [sic] τῶν Ἀντικυθήρων", *Παναθήναια* 7:

- 188-189.
- Rediadis, P. (1910), "Τὸ ἐξ Ἀντικυθῆρων ἀστρολάβον", *Αρχαιολογική* 10: 158-172.
  - Rehm, A. (1905), "Meteorologische Instrumente der Alten" (unpublished manuscript). Bayerische Staatsbibliothek, Rehmiana III/7.
  - Rehm, A. (1906a), "Notizbuch" (unpublished notebook). Bayerische Staatsbibliothek, Rehmiana III/7.
  - Rehm, A. (1906b), "Athener Vortrag" (unpublished paper). Bayerische Staatsbibliothek, Rehmiana III/9.
  - Rousopoulos, O. (1905), "Über die Reinigung und Conservierung der Antiquitäten", *Comptes rendus du congrès international d'archéologie. 1re session, Athènes 1905*. Athens, 250-255.
  - Stais, V. (1905), *Τὰ ἐξ Ἀντικυθῆρων Εὐρήματα*. Athens.
  - Stais, V. (1907), *Marbres et bronzes du Musée national* (= *Guide illustré* vol. 1). Athens.
  - Stais, V. (1910), *Marbres et bronzes du Musée national* (= *Guide illustré* vol. 1). 2nd ed. Athens.
  - Svoronos, I. (1903a), *Ὁ Θησαυρὸς τῶν Ἀντικυθῆρων*. Athens. Republished in Svoronos, I. (1908), *Τὸ ἐν Αθήναις Ἐθνικὸν Μουσεῖον*, Athens.
  - Svoronos, I. (1903b), *Die Funde von Antikythera*, Athens. Republished in Svoronos, I. (1908), *Das Athener Nationalmuseum*, Athens.
  - Theofanidis, I. [1927-1930], "Ἁγίου Παύλου (πλοῦς)", *Μεγάλη Στρατιωτικὴ καὶ Ναυτικὴ Ἐγκυκλοπαίδεια* 1 83-96 (pp. 89-96 are misnumbered as 97-104.)
  - Theofanidis, I. ("Jean Théophanidis") (1934a), "Sur l'instrument en cuivre dont les fragments se trouvent au Musée Archéologique d'Athènes et qui fut retiré du fond de la mer d'Anticythère en 1902", *Πρακτικὰ τῆς Ἀκαδημίας Ἀθηνῶν* 9: 140-149.
  - Theofanidis, I. ("Jean Théophanidis") (1934b), "Sur la navigation astronomique des anciens Grecs", *Πρακτικὰ τῆς Ἀκαδημίας Ἀθηνῶν* 9: 149-153.
  - Throckmorton, P. (1970), *Shipwrecks and Archaeology: The Unharvested Sea*. Boston.
  - Tracy, S.V. (1970), "Identifying Epigraphical Hands. I", *Greek, Roman and Byzantine Studies* 11; 321-333.
  - Tracy, S.V. (2000), "Dating Athenian Inscriptions: A New Approach", *Proceedings of the American Philosophical Society* 144: 67-76.
  - Tracy, S.V. (2009), "Dating by Lettering in Greek Epigraphy", in Fernández, A.M. (ed.), *Estudios de epigrafía griega*. La Laguna, 105-112.
  - Vicars, E. (1903), "A Rescued Masterpiece: The Finds at Anticythera", *The Pall Mall Magazine* 29 (120): 551-562.
  - Vyzantinos, G. (1901a), "Εἰς τὸν βυθὸν τῶν Ἀντικυθῆρων", *Παναθήναια* 1:224-227.
  - Vyzantinos, G. (1901b), "From the Bottom of the Sea", *The Independent* 53(2730), March 28, 1901, 704-706.
  - Woodhead, A.G. (1967), *The Study of Greek Inscriptions*. Cambridge.
  - Wright, M.T. (2006), "The Antikythera Mechanism and the Early History of the Moon-Phase Display", *Antiquarian Horology* 29: 319-329.
  - Wright, M.T. (2007), "The Antikythera Mechanism Reconsidered", *Interdisciplinary Science Reviews* 32: 27-43.
  - Wright, M.T. (2011), "The Antikythera Mechanism: Reconstruction as a Medium for Re-

search and Publication", in Staubermann, K. (ed.), *Reconstructions: Recreating Science and Technology of the Past*. Edinburgh, 1-20.

- Wright, M.T., Bromley, A.G., Magou, H. (1995), "Simple X-Ray Tomography and the Antikythera Mechanism", In Liritzis, I., Tsokas, G. (eds), *Archaeometry in South Eastern Europe: Second Conference in Delphi, 19th-21st April 1991*. PACT 45. Rixensart (Belgium), 1995.
- Zafeiropoulou ["Zapheirpoulou"], M. (2012a), "Old and New Fragments of the Antikythera Mechanism and Inscriptions", in Kaltsas, N., Vlachogianni, E., Bouyia, P. (eds), *The Antikythera Shipwreck: the ship, the treasures, the mechanism. Exhibition catalogue*. Athens, 241-248.
- Zafeiropoulou ["Zapheirpoulou"], M. (2012b), "The Antikythera Shipwreck and the Treasures", in proceedings of "From Antikythera to the Square Kilometre Array," *Proceedings of Science PoS(Antikythera & SKA)006*. Athens.
- Zinner, E. (1931), *Geschichte der Sternkunde von den ersten Anfängen bis zur Gegenwart*. Berlin.
- Zinner, E. (1943), *Entstehung und Ausbreitung der Copernicanischen Lehre*. Erlangen.

