THE AHMOSE TEMPEST STELA:
AN ANCIENT EGYPTIAN ACCOUNT OF A NATURAL CATASTROPHE

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1. The Ahmose Tempest Stela: the text and its significance
[by Robert K. Ritner]

A link between the catastrophic eruption of the Thera volcano and an unusual stela erected at Karnak during the reign of Pharaoh Ahmose, the first ruler of Egypt's New Kingdom, has been suggested, rejected and defended in multiple studies since the initial publications of the stela's fragments by Claude Vandersleyen[1]. The first suggestion of such a link appeared in a brief note by Ellen Davis[2], and this proposition was defended in an expanded discussion of the stela published by Karen Foster and myself six years later[3]. Objections soon followed, typically adopting parallel lines of argumentation. Although the wording of the Egyptian text explicitly describes an unparalleled storm with rain, darkness, noise, flooding and destruction affecting the whole country (twice "the Two Lands", once "this entire land"), many commentators – beginning with Vandersleyen – have sought to minimize the implications of the account since it cannot be reconciled with typical climactic episodes in Egypt. Instead, the inscription has been reinterpreted either because 1) it cannot mean what is says, and references to Egypt *in its entirety* are unparalleled expressions for a non-specific "anywhere" (in Upper Egypt alone)[4]; or 2) the extensive descriptions of rain, darkness, noise, flooded houses, districts and tombs, and overthrown enclosure walls and cult images are all simply "metaphors" for the otherwise unmentioned Hyksos[5]. To accomplish these distortions of the text, lexical parallels have been ignored or invented, lines added without justification or parallel, a year date fabricated, and texts of related genres conflated and confused. A full response to these critiques is now in

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1 For the text, see the original publications in Vandersleyen 1967; 1968; with re-editions in Helck 1983, 104-110; and Klug 2002, 35-46.

2 Davis 1990.

3 Foster - Ritner 1996.

4 Vandersleyen 1967, 133, 140 n. 24, 143 n. 36, 145, 148-149 n. 54, 155-156; followed by Davis 1990, 232-233; Wiener - Allen 1998, 19.

5 See Ryholt 1997, 144-145; Wiener - Allen 1998, 13-14, 19, 20-21, 27; Manning 1999, 197-199; Klug 2002, 45; Schneider 2010.

press by Robert K. Ritner and Nadine Moeller[6], and the comments below are confined to new issues raised publicly or in conversation during the most valuable conference on "Reading Catastrophes" sponsored by Sapienza Università di Roma and the Consiglio Nazionale delle Ricerche in Rome on 3-4 December 2012.

First, however, for the convenience of the reader, a full translation of the Ahmose Tempest Stela is provided here. With only minor variations, the same text was carved on both sides of the stela, so that restorations of the broken sections can often be restored. The spacing and line numbers (18 vs. 21) differ on the two faces, and the following translation is based on the Recto with 18 lines. For explanations of individual terms, the reader is referred to the forthcoming publication by Ritner and Moeller.

1.1. *Tempest Stela running translation*

(1) "[Long live (?) the Horus "Great of Manifestations", He of the] Two Ladies "Pleasing of Birth", the golden Horus "Who binds the Two Lands", King of Upper and Lower Egypt, Neb-pehty-Ra, son of Ra, Ahmose, living forever.

"Now then, His Majesty came [...] (2) since(?) Ra himself had appointed him to be king of Upper Egypt".

"Now, His Majesty dwelt in the town of Sedjefa-tawy ("Provisioner of the Two Lands") (3) [in the district just to] the south of Dendera. Now then, A[mon-Ra, Lord of the Thrones of the Two Lands,] was in Heliopolis of Upper Egypt (= Thebes)".

"It was His Majesty who went south ("upstream") in order to [give to him bread, beer and everything good and] pure. (4) Now after the offering, [...] (4) their(?) [...]. Then attention as given in [...] this [dis]trict. Now then, the cult image [of this god ...] (5) [...] as his body was installed in (lit. "united with") this temple while his limbs were in joy. [...]".

"[... Now then], this great god desired [...] His Majesty [...] while the gods complained of their discontent. [Then] the gods [caused] that the sky come in a tempest of r[ain], with [dark]ness in the condition of the West, and the sky being in storm without [cessation, louder than] the cries of the masses, (8) more powerful [than ...], [while the rain howled] on the mountains louder than the sound of the underground source of the Nile that is in Elephantine".

"Then every house, every quarter that they (*scil*. the storm and rain) reached [... their corpses(?)] floating on the water like skiffs of papyrus

[6] Ritner - Moeller in press.

outside the palace audience chamber for a period up to [...] days [...] while no torch could be lit in the Two Lands".
"Then His Majesty said: 'How much greater this is than the wrath of the great god, [than] the plans of the gods!' His Majesty then descended to his boat, (11) with his council following him, while the crowds [on] the east and west had hidden faces, having no clothing on them after the manifestation of the wrath of (12) the god. His Majesty then reached the interior of Thebes, with gold confronting gold of this cult image, so that he received what he desired".
"Then His Majesty (13) began to reestablish the Two Lands, to give guidance (or "a conduit") for the flooded territories. He did not f[ail] in providing them with silver, with gold, with copper, (14) with oil and cloth comprising every bolt that could be desired. His Majesty then made himself comfortable (= seated himself) within the palace (life! prosperity! health!). Then His Majesty was informed (15) that the mortuary concessions had been entered: the tomb chambers collapsed, the funerary mansions undermined, and the pyramids fallen – what had been made non-(16)existent (lit. "what had not been made"). Then His Majesty commanded to restore the temples that had fallen into ruin in this entire land: to refurbish the monuments of the gods, to erect (17) their enclosure walls, to provide the sacred objects in the noble chamber, to mask the secret places, to introduce into their shrines the cult images which were (18) cast to the ground, to set up the braziers, to establish their bread offerings, to double the income of the personnel, to put the land into its former state. Then it was done in accordance with all that His Majesty had commanded".

1.2. *A modern parallel?*

In discussion following the lecture in Rome by Robert K. Ritner and Nadine Moeller, Rainer Stadelmann remarked at length on his personal witness of the devastation created in Egypt during the Fall of 1994 and insisted that the Ahmose description must reflect only a similar storm. In this suggestion, Stadelmann was anticipated in 1998 by Jim Allen, who considered the Ahmose and 1994 events "similar storms"[7], with the ancient tempest "comparable to the recent storm of 1994, which caused flooding both in Luxor and the Cairo area"[8]. A comparison with the 1994 storms was in no sense, however, an issue irrelevant to the initial discussion of the

[7] Wiener - Allen 1998, 18.
[8] Wiener - Allen 1998, 19.

Ahmose Stela by Karen Foster and myself, since she first questioned me regarding the implications of the text in 1994, when the contemporary events in Egypt were unavoidable. That storm was not a factor in the resulting 1996 publication for quite simple reasons. Neither the extent nor the duration of the 1994 storm can be considered "comparable" to the catastrophe recorded in the reign of Ahmose.

With more than 500 individuals killed[9] by a combination of flash floods and oil fires, the severity of the 1994 disaster should not be denied, but as Allen noted, it was limited in its regional scope. The fast moving storm damaged seven small villages near Asyut, with the greatest destruction in the villages of Durunka and Minshaat el-Arab. In the latter village, flood waters ruined all homes, and five bodies were found in the rubble. Most deaths, in contrast, were due only indirectly to the flooding and occurred in Durunka, where a collapsed bridge set ablaze two Egyptian army oil storage tanks containing about 15,000 tons of petroleum: " 'Huge amounts of water that were collected on the western mountain went down in terrible force toward the storage tanks, causing an electrical short that also caused a huge explosion in one of the tanks at 5:55 a.m.', Al Ahram reported in its early edition today. The resulting fires apparently ignited fuel in a nearby pipeline, and floodwaters swept the burning fuel down into the village, igniting hundreds of homes along the way"[10].

In Cairo, streets were flooded with particular damage in the crowded alleyways of old Cairo and the adjacent market of Muski. Nine houses collapsed and many vendor stalls. In Luxor, flooding seriously damaged tombs and monuments on the West Bank, but "the whole event took less than 15 minutes"[11]. The storm then moved east over the Sinai Peninsula into Israel[12].

When comparing the 1994 flood to the events recounted in the Ahmose Tempest Stela, one must obviously leave aside the modern oil fires, inapplicable to pre-petroleum technology and ancient events. Equally

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[9] Theban Mapping Project, Chapter 2, online at: http://www.thebanmappingproject.com/about/KVMasterplan/KVM_CH2.pdf, 58 (last accessed March 13, 2013).

[10] Murphy 1994a; and Chicago Tribune, November 2, 1994, online at: http://articles.chicagotribune.com/1994-11-02/news/9411030167_1_assiut-fuel-floods (last accessed March 13, 2013).

[11] Murphy 1994b; and Theban Mapping Project, Chapter 2, online at: http://www.thebanmappingproject.com/about/KVMasterplan/KVM_CH2.pdf, 59 (last accessed March 13, 2013).

[12] Krichak - Tsidulko -Alpert 2000.

distinctive are the durations of the two events. Although the 1994 storm left considerable floodwaters in the Cairo and Luxor areas, the thunderstorms were brief: "Egyptian meteorologists reported that a an inch of rain fell on Cairo during a two-hour period Wednesday morning in the worst rainstorm since November, 1957, when three-quarters of an inch fell during a 24-hour period[13]".

In stark contrast, the Ahmose events continued not for hours, but for a period of days. I am indebted to Marina Baldi, climatologist with the Istituto di Biometeorologia (Ibimet) of the Consiglio Nazionale delle Ricerche, for stressing the significance of this extended duration in conversation following the joint lecture in Rome. As can be seen in the translation above, the Ahmose storm continued "for a period up to [...] days [...] while no torch could be lit in the Two Lands" (ll. 9-10 Recto = ll. 11-12 Verso). Although the precise number of days is lost on both faces of the stela, the use of the phrase ḥnty r hrw **[...]** indicates a lengthy time period, not simply a few days, which would be commonly written n hrw X "for X days"[14]. Allen has carefully measured the available space for possible restorations and concluded on the basis of Egyptian number groupings that "the duration is thus 4-5, 7-9, 14-19, or 24-29 days, with the lower numbers most likely"[15]. Allen is correct that more than 29 days probably would have been described in terms of months rather than days, but his preference for the lower range of numbers is based only on his preconceptions regarding the nature of the storm. In any case, all of these number ranges indicate an event of a far greater magnitude than the 1994 storm. Felt throughout the country and for a lengthy time, the Ahmose-era tempest is unparalleled in historical records of ancient or modern Egypt.

1.3. *A mythological parallel?*

If genuinely historical records provide no parallel for Ahmose's tempest, it may yet be possible that the event left a reflection, however distorted, in later mythological tales. Given the destruction that even the brief rains of 1994 could cause, the more prolonged events in the early New Kingdom might have influenced further theological speculation. Again, I am indebted to discussions following the presentation, in particular to Dora Ventura and Professor Vincent Laisney from the Pontificio Istituto Biblico in Rome, who

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[13] Murphy 1994a.

[14] See the standard use of ḥnty for "long time" in Erman - Grapow 1957, Vol. III, 106.

[15] Wiener - Allen 1998, 12.

raised the issue of the storm recorded on a late naos of the Museum of Ismalia (number 2248), discovered in el-Arish. The nature of this text makes it distinct from the Ahmose documentary account, but it has been included in discussions of the Thera eruption, on the assumption that it is a "mythologized rendering of the history of the early Eighteenth Dynasty"[16]. Within the narrative, Egypt is subjected to several disturbances of a cosmic nature: while under the reign of the god Shu, Egypt was attacked from the east by the "children of Apep", and Geb lusted for his mother Tefnut with distracted heart so that the land became ill.

ꜥḥꜥ.n{n} ṯ.n=f sy m ꜥwꜣy.t ḫn[n p]w ỉr.n ḥnw r ꜥꜣ wr.t Šw pw ḥrỉ=f r

p.t ỉw nn wnn pr m ḥnw r ꜥḥꜥy n h(r)w 9 ỉr h[(r)w 9] pn m nšn dꜥ.w

pw nn mꜣꜣ ḥr n snw=f ỉn rmṯ.w nṯr.w

"Then he seized her by plunder. The residence was disrupted very greatly. It was the case that Shu withdrew up to heaven, while none went forth from the palace up to a period of 9 days. As for these 9 days in raging, they were storms, without the seeing of the face of his fellow by men or gods"[17].

The rape of Tefnut by Geb and the resultant feud between him and his father Shu is known as well from the Demotic Magical Papyrus of London and Leiden, but without mention of a time period[18]. While the children of

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[16] So Goedicke 1992, 61. Goedicke assumed that the narration reflected Egypt "specifically from Thutmosis I to the resumption of his sole rule by Thutmosis III". The problematic nature and misuse of the text is noted in Ritner - Moeller in press, n. 103. The text was first published in Griffith 1890, 70-74, pls. xxiii-xxvi; with a re-edition by Goyon 1936. A brief overview appears in von Bomhard 2008, 243-244. I thank Dora Ventura for additional bibliography on the naos.

[17] For the text, see Griffith 1890, 72 (ll. 7-8); and Goyon 1936, 14-15, 32. As the determinative for ḥrỉ and throughout the edition by Goyon, the road sign (Gardiner Sign List N 31) was misread as a star (Gardiner Sign List N 14); see Goyon 1936, 31, n. 1 (misreading dwꜣ.t "underworld" for wꜣ.t "path/road").

[18] Column XIII, 1-10; see Betz 1992, 217; *contra* Verhoeven 1991, 327 (followed by von Bomhard 2008, 243), who adopts Griffith's admittedly questionable restoration "[the daughter of]" before "his mother Tefnut" in this passage. As Geb is the full brother of Nut, there is no reason to designate the latter with terminology reserved for a maternal half-sister: "the daughter of his mother". The similarity of the two mythological episodes, with sexual attacks by Geb provoking domestic hostility with his parents, cannot be discounted. Further, the statement

Apep might be a veiled reference to the Hyksos – or to the Assyrians, Persians[19] or simply mythological creatures – the domestic palace trauma among Shu, Tefnut and Geb has no referent in the era of Ahmose, and the el-Arish tale cannot be considered a mythical *roman à clef* disguising New Kingdom historical figures. Even the description of the nine "days of rage" within the palace as "storms" may be metaphorical, with the inability to see faces due to closeted deities and limited access. However, the reference to a disturbance "up to a period of 9 days" is interesting when compared to "for a period up to […] days", even if the word for "time period" (ꜥḥꜥy < ꜥḥꜥw) is not identical with the term ḥnty used in the Ahmose Stela. Perhaps a vague historical memory of such a 9-day storm remained in the Egyptian cultural consciousness, but this is necessarily speculative since the actual number of days in the Ahmose Stela is unknown, although nine is a possibility.

1.4. *A question of dates*

Regarding the date of the Ahmose Stela itself, all that can be said with certainty is that it was carved before regnal year 22, when the writing of the Ahmose's name was modified, inverting the lunar crescent in the king's Nomen. On the basis of parallel stelae from Ahmose's reign, Cairo 34001 and 34002[20], it is unlikely that any regnal year was included at the beginning of the text[21]. Regarding the absolute chronology of Ahmose's reign, however, much more can be said, and that discussion appears in the following section by my colleague Nadine Moeller. The convergence of radiocarbon data, from multiple sites and multiple sources, realigns the dates for both the Santorini eruption and the reign of Ahmose[22].

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that Geb's heart "became forgetful after her" evokes the usual Egyptian descriptions of love sickness, in which the smitten lover "does not know where he is". Cf. also the naos phrase t n ꜥwꜣy.t (Erman - Grapow 1957, vol. I, 171) with Demotic t n qns "to take by force" = "to rape" in Erichsen 1954, 542.

[19] So Schneider 1998, who dates the naos to Nectanebo II and considers it a mythological legitimization of Dynasty 30 and its struggles against the Persians.

[20] Lacau 1909, 1-6, pls. 1-2.

[21] For a full discussion of these issues, see Ritner - Moeller in press.

[22] A seeming disparity appears in the ^{14}C dates published for Tell el-Dabᶜa, discussed below. However, these calculations are anchored by the preconception that the reign of Ahmose and his conquest of Avaris can be firmly dated to ca. 1530 BC (Kutschera *et al.* 2012, 410, fig. 3, and 420), an assumption that the present paper clearly disputes. The presumption of a firm date necessarily impacts the resultant conclusions.

2. The date of the Thera eruption [by Nadine Moeller][23]

The Minoan eruption of Santorini has been for the past decades one of the main issues regarding the absolute chronology in the eastern Mediterranean region. The exact date for the eruption is a very important marker and reference point for linking and synchronizing various floating chronologies in the eastern Mediterranean and the Levant. In 1996, when the first article by Robert K. Ritner and Karen Foster was published, the absolute date for the Thera eruption was still a matter of debate and two date ranges had been proposed that were about 100 years apart from each other. This has led to the existence of two models, one supporting a high and the other a low chronology[24]. On the basis of archaeological evidence, the Minoan eruption had been placed some time during the end of the 16th century BC (ca. 1524-1500 BC), which corresponds to the early 18th Dynasty, while radiocarbon dates and tree ring data combined with evidence from ice cores pointed to a date about hundred years earlier in the 17th century BC, where it takes us to the end of the Second Intermediate Period[25]. This situation changed considerably in 2006, when a study of new radiocarbon dates was published of samples taken from a branch of an olive tree that had been buried alive during the Thera eruption[26]. The tree had been covered by several meters of pumice but remnants of its branches and leaves have been excavated providing good evidence that the tree had been alive when this event happened. Another fortunate finding was that the complete set of tree rings of the branch had been preserved. This made it the ideal short-lived example for radiocarbon dating that would offer a ^{14}C date with a much more limited error range (at 2σ = 95% probability) than before. A series of calibrated radiocarbon dates from a defined sequence of tree rings in the olive tree branch was obtained[27]. Since olive trees in general have slightly uneven and often scarcely visible tree rings x-ray tomography was used to identify the complete number of rings in a section of the branch including its bark[28].

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[23] This article is an expanded version of a discussion on the Thera eruption date and the Ahmose Stela; see Ritner - Moeller in press.

[24] Foster - Ritner 1996, 8-9.

[25] These two possibilities have generated many publications arguing for one or the other date. See for example the debate between Manning 1999, who favors the high chronology for the Aegean region, while Bietak 2003 defends the younger date.

[26] See Friedrich *et al.* 2006a; Manning *et al.* 2006; Balter 2006.

[27] Manning *et al.* 2006, 566. The calibration was made by using the IntCal04 curve.

[28] Friedrich *et al.* 2006a, fig. 1c.

The calibrated age range that has been obtained for the outermost ring, which marks the year the eruption happened, is now at 1621-1605 BC (1σ, 68% confidence) and 1627-1600 BC (2σ, 95% confidence)[29]. The very tight date range for both the 1σ and 2σ values shows clearly the extremely high precision of the date for this event. After the initial publication of the results in 2006, several concerns were raised as to the reliability of the dates obtained[30]. In a recent publication from 2009, the same group of scientists who had carried out the initial dating and research wrote a follow-up article in order to respond to these questions[31]. None of the arguments against the accuracy of the Thera eruption dates brought forward give any reasons for concern as they could all be satisfactorily answered. In a recent article by Felix Höflmayer, the ^{14}C dates of short-lived samples (seeds, twigs etc.) from Akrotiri have been re-evaluated by combining the 28 published measurements before calibration[32]. He generates two models, one that considers the samples as reflecting the same moment in time of the occupation of the settlement (± 1-2 years) prior the eruption and the second which treats the measurements as a "phase" relating to the final occupation of Akrotiri[33]. Both models are making use of two different functions currently available in the OxCal program. The results of these two models both show dates that lie in the second half of the 17th century BC, which is in accordance with the proposed eruption date from the olive tree branch[34].

Additional radiocarbon samples from the site of Aegina Kolonna, a multi-period settlement situated in the center of the Saronic Gulf between mainland Greece and the Peloponnese, as well as from tsunami deposits at Palaikastro at the north-eastern coast of Crete support the high date[35].

In view of all this evidence, the previously proposed younger date around 1520 BC can now be fully excluded in view of these new scientific results. The recently established date range for the Thera eruption can be regarded

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[29] Friedrich *et al*. 2006a.

[30] See for example various points raised by regarding this debate in Wiener 2009.

[31] Friedrich *et al.* 2009.

[32] Höflmayer 2012.

[33] Höflmayer 2012, 436-438. Höflmayer used the *R_Combine* function of the OxCal program prior to calibration for this calculation for the first model and the *Tau_Boundary* function for the second.

[34] Höflmayer 2012, figs. 1-2. The result of the first model proposes a date range of 1642-1616 BC (at 48.1 %) and 1682-1608 (at 95.4%), while the second model resulted in a 1632-1611 BC (68.2 %) range.

[35] Höflmayer 2012, 438-439.

as secure and reliable; any younger date in the 16th century BC can now be safely dismissed according to the evidence presented above[36].

2.1. *Implications for the Egyptian chronology*

2.1.1 The current standing of Egyptian absolute chronology

As outlined in the first part of this article by Robert K. Ritner, the Ahmose Tempest Stela contains very unusual descriptions of a natural catastrophe, which focused on the widespread destruction caused by a very strong storm. It has also been proposed that there is a link between the eruption of Thera and the kind of effects being witnessed in Egypt as described on this stela. Now, with the new absolute dates established for the Thera eruption, it is necessary to investigate how this fits to the Egyptian chronology and the dates for the reign of king Ahmose, first ruler of the 18th Dynasty.

In 2010, new results for a radiocarbon-based chronology for dynastic Egypt were published within the framework of the Egyptian Chronology Project (Research Laboratory for Archaeology and the History of Art, University of Oxford)[37]. The analysis incorporates statistical models in combination with radiocarbon dates, a method which has provided a new data set for the absolute chronology in Egypt. The published results show that from the New Kingdom and later the results correspond quite well with the previously proposed historical dates with an error margin that falls between 24 and 11 years, while the dates of earlier periods such as the reigns dating to the third millennium BC show more of a discrepancy of about 76 years[38].

For a long time, Egyptian chronologies have been established by means of a variety of historical and archaeological sources that offer primarily relative chronological sequences for Dynastic Egypt (such as king-lists, monumental records, textual sources and ceramic sequences to name just a few). Those were then tied to absolute dates by means of a small number of ancient astronomical dates, which come especially from the Middle and New Kingdoms[39]. The fact that many of the recorded celestial

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[36] The fact that radiocarbon measurements from sites other than Santorini such as Palaikastro in Crete and those from Aegina Kolonna confirm the high date for the Thera eruption should silence any of the voiced criticism about the reliability of the radiocarbon dates from Santorini. See the discussion by P. James who seriously questions the validity of the date obtained from the olive tree branch (James 2012).

[37] Bronk Ramsey *et al.* 2010.

[38] Bronk Ramsey *et al.* 2010, 1556, tab. 1551.

[39] See for example recent discussions about Egyptian astronomical data by Luft 2003; and Krauss 2003.

and lunar phenomena occur at regular intervals has been a promising starting point for establishing several fixed dates within the Egyptian chronology. Unfortunately, these observations are strongly dependent on the ancient location from where these were made but those were not clearly stated in the ancient records. Thus a number of very different dates are possible, a fact that adds too many uncertainties and has generated a never-ending discussion amongst scholars. Other attempts to synchronize the Egyptian chronology with absolute chronologies established for neighboring civilizations are only feasible from the mid-18th Dynasty of the New Kingdom onwards[40].

However, radiocarbon dating, a method that generates independent absolute dates, has been frequently criticized in the past because of large error margins (between 100 and 200 years at the 2σ (95%) range) that are too wide for the precision that is needed for Egypt's dynasties[41]. In order to solves this issue and provide a more reliable dataset, the above-mentioned Oxford project was set up. The Oxford team chose carefully selected samples that were short-lived plant remains held in museum collections in order to minimize large error ranges and achieve high precision. Such samples used for radiocarbon dating included selections of seeds, pieces of basketry and plant-based textiles as well as fruits[42]. The choice of these was based on the condition that they were directly linkable to particular reigns. Charcoal, wood and mummified material was excluded because of possible contamination or inherent older ages, which is the case for wood and charcoal. Most samples were chosen according to the archaeological

[40] See for example the latest article by on this topic by Kitchen 2007.

[41] Historical and archaeological data can often provide a range of $\pm$ 30 years or less, a fact which has led many scholars to refrain from using ^{14}C data. Another factor that makes attempts to have archaeological samples radiocarbon dated difficult is that there are strict regulations that prohibit any export of samples from Egypt. The only radiocarbon laboratory in Egypt is currently located at the Institut français d'archéologie orientale (IFAO) in Cairo, which does not have an accelerator mass spectrometry (AMS) facility and thus requires large sample sizes. This excludes the submission of many short-lived samples (such as seeds) that are ideal for acquiring precise dates. In the near future AMS might be possible at the IFAO and we have to expect this laboratory, which is currently seeing the submission of all archaeological samples from excavations in Egypt, to play an increasingly important role.

[42] See Bronk Ramsey *et al*. 2010, 1557, n. 1530. As the impressive list of institutions from which samples were used shows, many botanical samples came from the Oxford University Herbaria, the Natural History Museum in London and the famous Royal Botanical Gardens at Kew.

context and relation to a known king, but this of course comes also with some uncertainties since most of the samples have been excavated in the 19th and early 20th centuries, and most of them come from funerary contexts. In some cases several different samples from the same context were dated to check for internal consistency.

For the actual measurements only very small quantities of each sample were used because the radiocarbon measurements were made by accelerator mass spectrometry (AMS). By the end of this procedure, a total 211 AMS radiocarbon dates had been generated of which 188 were considered reliable. Those are the ones that were further used in the statistical models. Of these 188 dates, 128 were from the New Kingdom, 43 from the Middle Kingdom and 17 for the Old Kingdom[43].

The statistical model that was followed in order to establish the necessary high-precision chronological sequence is called the Bayesian modeling approach[44]. For this method the radiocarbon dates were combined with additional historical information such as reign length and reign order[45]. Uncertainties in reign lengths are relatively small but not insignificant for periods like the New Kingdom, which typically lie at 1-2 years as a margin of error (except for Thutmose I and II[46], Thutmose IV[47] and Horemheb[48]), but this becomes less precise for the earlier periods, which had to be quantified in the model, too. Additionally, environmental information was

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[43] Bronk Ramsey *et al.* 2010, 1555.

[44] See Bronk Ramsey 2009 for more details on the use of Bayesian analysis for radiocarbon dates. Bayesian statistics provide a good framework for radiocarbon dates. C14 dates are not dates at all but measurements of an isotope ration. To interpret them as dates it is necessary to perform some statistical analysis using a calibration curve.

[45] The dates published in Shaw 2000 were used for this model. The order of reigns did not include any absolute dates.

[46] Kitchen 2006, 303. Kitchen points out that the reigns of both rulers could be another possible source of error of 10-15 years in the chronology of the early 18th Dynasty.

[47] The reign for Thutmose IV has possibly been around 10-12 years but there in not enough conclusive data to be certain; see discussion by Bryan 1991, 25.

[48] See van Dijk 2008 for the latest discussion about the reign length of Horemheb, which argues for a reign of 15 years, which is based on wine jar labels from his tomb in the Valley of the Kings. A recent presentation by Karen Bryson at the Annual Meeting of the American Research Centre in Egypt held at Cincinnati, OH in April 2013 proposed a reign of around 28 years based on a graffito from Medinet Habu.

included when necessary[49]. Because the reign length has been included in these models, it is important to stress that the results that are generated by the Oxford chronology project cannot be used to provide independent reign length information!

2.1.2 Results for the early New Kingdom

The use of reign order and length together with radiocarbon dates shows the best results for periods which also have the highest number of radiocarbon dates such as the New Kingdom (128 dates). Here the average calendric precision is 24 years (for the 2σ 95% range) or 11 years (for the 1σ 68% range) for accession dates[50]. This is the period that concerns us most in connection with the Ahmose Stela. However, no dates were obtained for the Second Intermediate Period which precedes the New Kingdom because of the lack of samples that can be associated with a precise king.

The best-dated ruler for the early New Kingdom is Thutmose III for whom 24 radiocarbon samples were obtained. The results show that his rule is about 15-20 years older than the conventional dates provided by Shaw and Hornung[51]. However, no samples from any of his predecessors have been obtained and the dates for Amenhotep I and Ahmose are based on the estimated maximum number regnal years, which are 21 and 25 years respectively. There is of course the uncertainty for both Thutmose I and Thutmose II (3-4 or 13 years?) that needs to be taken into account, too[52].

Ahmose's reign falls under this newly established chronology at a date that is about 10-15 years older than previously assumed, and it is realistic to say that the low chronology which dates him to 1539 -1514 BC is very unlikely in the view of the dates obtained for Thutmose III. According to the currently known historical records for Ahmose, year 22 is the last attested regnal year and his reign length has been estimated at 25-26 years maximum[53]. Counting backwards using the maximum number of regnal years, Ahmose's reign is now suggested to have started between 1566 and 1552 BC (at the 1σ, 68% range) and 1570 to 1544 BC (for the

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[49] Such as the known depletion of radiocarbon levels relative to the calibration curve which corresponds to a shift to older dates by 19$\pm$ 5 C^{14} years; see Bronk Ramsey *et al.* 2010, 1555; Dee *et al.* 2010. Such a phenomenon probably linked to the perennial inundation has been noticed for the Old Kingdom, particularly the 4th Dynasty.

[50] Bronk Ramsey *et al*. 2010, 1555.

[51] The absolute dates published by Shaw are mean estimates made from various publications. The other source used is by Hornung - Krauss - Warburton eds. 2006.

[52] Krauss 2007, 182-183.

[53] Barbotin 2008, 67.

2σ range 95%). In this respect, Vera Müller has pointed out that by taking into account the various uncertainties in the reign lengths of the early 18th Dynasty rulers, the earliest possible date for the beginning of the reign of Ahmose would be 1580/1590 BC which fits well to the radiocarbon based date of the Thera eruption[54].

Already these dates show that 20-30 years of uncertainty still remain here. Another factor of much debate and inconsistency is the length of the Second Intermediate Period for which no date was obtained simply due to the problems of acquiring samples that can be securely connected to a specific ruler's reign. According to the new model, the reign of Amenemhat III is well defined with 10 samples showing also a slightly older reign of about a decade. If the beginning of the 13th Dynasty holds true (although there is this much debate about the identity of the first ruler)[55], then the period from the accession of the first king of the 13th Dynasty up to the end of the Second Intermediate Period lasted for about 200 years, which is in fact much shorter than earlier estimates[56].

However, from an archaeological perspective, especially in view of the latest results from the Middle Kingdom and Second Intermediate Period contexts at Tell Edfu, for which a complete and well-documented stratigraphic record exists, this time span seems much more realistic. It also fits well to the observed archaeological formation processes (life span and use, abandonment and re-building of major mud-brick buildings) as well as cultural developments (such as the evolution of the ceramic repertoire) recorded at Tell Edfu.

A recent discovery of more than 40 clay sealings naming the Hyksos ruler Khayan at Tell Edfu which were found in the abandonment layer of a large administrative building complex have contributed additional data to the debate of the chronology of the Second Intermediate Period. They were found together with nine sealings of the 13th Dynasty king Sobekhotep IV who usually is considered to have reigned almost 80 years prior to Khayan[57]. The new archaeological evidence now suggests that these two

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[54] Müller 2006, 226.

[55] For a summary of this debate, see Ryholt 1997, 315-321.

[56] See for example Schneider 2008, who suggests a time span between 270 and 304 years for the 13th and 17th Dynasties.

[57] The first radiocarbon date obtained from this archaeological context provides a date of 1750-1664 BC at 65.9 % probability (1σ range) according to the report IFAO-0422; see also Moeller - Marouard - Ayers 2012, 97. One sample is of course not enough to be conclusive and further samples will be analyzed in the near future as part of a wider chronology project; see note 38.

reigns were much closer than previously thought and further corroborate the shorter time span for the Second Intermediate Period, which would lie closer at 250-270 years than 300+ years[58]. In this respect it is also worth mentioning that the recent publication of a series of radiocarbon measurements from Tell el-Dab^{c}a shows an important offset of about 120 years between the ^{14}C dates and the archaeological data[59]. So far there has been no satisfying solution for explaining the discrepancy between the chronological sequence established by the excavators of the ongoing excavations at Tell el-Dab^{c}a and the dates obtained from the radiocarbon measurements.

However, phases D2 and D1, which have been assigned to the reign of Ahmose, show ^{14}C dates in the late 17th century BC. This would also fit quite well with the older date for Ahmose as has been proposed here[60].

2.2. *Conclusions*

In view of the new date for the Thera eruption and the recent evidence for an older chronological sequence in absolute terms for the New Kingdom and the Middle Kingdom, Ahmose is currently dated 30 to 50 years later than the volcanic event.

However, as has been shown in the discussion on the Egyptian absolute chronology, the dates for Ahmose are by no means fully fixed yet and this gap in time can easily be reduced[61]. Additionally, there is a problem related to the absence of any reliable absolute chronological data for the Second Intermediate Period[62].

In view of the unusually detailed description of a major climatic event on the Tempest Stela, combined with the shifting chronology, we must now consider the possibility that the Thera eruption had been witnessed by Ahmose himself. Furthermore, the eruption certainly affected a large part of the eastern Mediterranean and it would have remained part of an oral tradition that was fresh in the memory of the people for a long time

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[58] This fits to some extent to the results of the re-evaluation of historical and astronomical data for the Middle Kingdom and Second Intermediate Period; see Schneider 2008.

[59] Kutschera *et al.* 2012.

[60] Kutschera *et al.* 2012, 410-412, fig. 3, tab. 1a.

[61] It has to be noted that if the older calibration curve IntCal98 is used, the dates for the Thera eruption have a slightly lower limit, extending down to 1575 BC (2σ) while high limits remain almost the same; see Friedrich *et al.* 2006b, 2-3.

[62] The author is currently preparing a new project on the absolute dates of the First and Second Intermediate Periods in Egypt.

afterwards. But the stele emphasizes the fact that Ahmose himself witnessed the event, which seems to exclude him using a second hand account (see above).

Another plausible explanation for the unusual thunderstorm Ahmose witnessed is that it might have not been the eruption itself, but its aftermath, a short-term climate change episode that affected a very large region including all of Egypt. This climatic episode would have severely interrupted the usual weather patterns in Egypt, which might have been the reason why it was commented upon in the textual record such as the Tempest Stela and the Rhind Mathematical Papyrus (see above). This episode marked by increased storms and rainfall probably lasted only for a few years, which is not long enough to be detectable for example in the pollen record[63].

This would still place Ahmose close in time to the eruption itself. From modern volcanic eruptions such as the one at Krakatoa in 1883, it is known that numerous after-effects are darkened skies, lower temperatures and chaotic weather patterns lasting several years[64]. It would be interesting to investigate whether a slight drop in the average temperatures by 1-2 degrees Celsius would lead to an increased formation of severe thunderstorms over Egypt, but no such study is currently available to our knowledge. In a recent article about the precise stages of the eruption at Thera and its aftermath, F.W. McCoy summarizes various phenomena that Late Bronze Age peoples in the Aegean and eastern Mediterranean are likely to have experienced[65]. These phenomena sound remarkably similar to the various observations mentioned in the Ahmose Stela such as the extremely loud explosion, earthquakes and darkness. The latter can be attributed to the tephra cloud, which would have plunged Thera and neighboring islands in a prolonged period of darkness for several days[66]. In

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[63] For example, the most recent study on climatic changes detected in Egypt does not provide any evidence for the 17th century BC, but clearly shows drier conditions during the First Intermediate Period; see Bernhardt - Horton - Stanley 2012.

[64] It is unlikely that the eruption caused the collapse of the Minoan civilization of Crete, but its climatic impact was certainly significant for several years; see the discussion by Manning - Sewell 2002.

[65] McCoy 2009, 88-90. This is mainly based on comparisons with historical data from various recent large eruptions, none of which was as strong as the one in Late Bronze Age Thera.

[66] For example, such darkness has been witnessed at a distance of 600 km for two days after the eruption of Mount Tambora in Indonesia, where the explosion was also heard at least as far as 2000 km away. The distance between Thera and

addition, McCoy proposes that thunderstorm-like weather conditions developed within the eruption plumes causing extremely strong rainfall in much of the southern Aegean. Archaeological and geological evidence has also left traces for severe destruction along the coastal regions of the Aegean and the eastern Mediterranean from tsunamis[67]. In this context the superior strength of the Thera eruption[68] to those volcanoes for which we have historical records needs to be emphasized and it remains difficult to estimate the precise range of regions being affected and by what intensity.
Some traces for the Thera eruption have been found at the settlement site of Tell el-Dab^{c}a in the eastern Delta. During the excavations, pumice was found in secondary contexts, such as workshops where it had been used as abrasive material and was collected specifically for this use[69]. Only few elements of pumice were directly deposited in the Delta by aeolian forces while most of the pumice had been washed ashore in the form of pumice rafts[70]. Contemporary studies about floating amounts of pumice from recent volcanic activity in the south-west Pacific have shown that the long-distance dispersal of pumice via the sea could occur relatively rapidly depending on the relevant ocean currents. For example, the 2006 eruption of the Home Reef Volcano in Tonga generated a substantial amount of pumice floating on the ocean surface forming rafts, which drifted for a distance of several thousand kilometers of 7-8 months[71]. It thereby plays an important role for the transport of marine life, and this recent study also confirmed that pumice could stay afloat for more than 2 years[72]. The ocean currents play an important role in the dispersal of the pumice. In the eastern Mediterranean the circulation of ocean currents move eastwards from the Aegean region where they would reach the coast of Egypt[73]. By

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Dendera is approximately 1320 km and about 750 km between the Delta and the island.

[67] Bruins - van der Pflicht - Macgillivray 2009; Bruins *et al.* 2008. See also McCoy 2009, 86-87, for further discussion and references.

[68] The Volcanic Explosivity Index (VEI) of the LBA eruption at Thera has been estimated to be > 7. For comparison, Mt. St. Helens had a VEI of 5, Krakatau a VIA of 6 and Tombora a VEI of 7. McCoy states that Thera was at least 1.5 times stronger than Tombora, see McCoy 2009, 84.

[69] See Bichler *et al.* 2003; Bietak 2003, 28 for further details.

[70] See also Foster *et al*. 2009, 174-176.

[71] Bryan *et al.* 2012.

[72] Bryan *et al.* 2012, 10-11.

[73] Poulain - Menna - Mauri 2012, see especially p. 987, fig. 912. This is based on the recent conditions in the eastern Mediterranean, which might have been

considering the speed in which pumice rafts could travel, it is most likely that pumice was washed ashore within a few months after the eruption. What is difficult to estimate is the lapse of time which passed before people started collecting the pumice and making use of it. According to the archaeological evidence, pumice in Egypt has not been found prior to the 18th Dynasty, but the presence of pumice can only be used as a *terminus ante quem* for the eruption of Thera and does not provide any additional data for the date of the eruption itself[74]. As a final point it is necessary to emphasize that such a major natural catastrophe would have seriously affected a wide range of civilizations around the eastern Mediterranean and it would have remained in people's memories for a long time. That said, it is remarkable that we have no concrete records of accounts from anywhere in this region by people who had witnessed the Thera eruption more closely. An influx of new data is obliging us to revise the chronology of the Middle Kingdom, Second Intermediate Period, and the New Kingdom. It is now time to consider the possibility that the Tempest Stela is indeed a contemporary record of the cataclysmic Thera event.

Bibliography

BALTER, M.
2006 "New Carbon Dates Support Revised History fo Ancient Mediterranean", in *Science* 312 (5773) (2006), pp. 508-509.

BARBOTIN, C.
2008 *Ahmosis et le début de la XVIIIe dynastie* (Les Grands Pharaons), Paris 2008.

BERNHARDT, C.E. - HORTON, B.P. - STANLEY, J.-D.
2012 "Nile Delta vegetation response to Holocene climate variability", in *Geology* 40 (2012), pp. 615-618.

BETZ, H.D.
1992 *The Greek Magical Papyri in Translation Including the Demotic Spells* (2nd edition), Chicago 1992.

BICHLER, M. - EXLER, M. - PELTZ, C. - SAMINGER, S.
2003 "Thera Ashes", in M. BIETAK (ed.), *The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. II* (Contributions to the Chronology of the Eastern Mediterranean 4), Vienna 2003, pp. 11-21.

BIETAK, M.
2003 "Science versus Archaeology: Problems and Consequences of High Aegean Chronology", in M. BIETAK (ed.), *The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. II* (Contributions to the Chronology of the Eastern Mediterranean 4), Vienna 2003, pp. 23-33.

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somewhat although probably not drastically different. Some seasonal variation needs to be taken into consideration, too.

[74] Höflmayer 2012, 441-442; see also the discussion by Sterba *et al.* 2009.

VON BOMHARD, A.-S.
2008 *The Naos of the Decades*, Oxford 2008.
BRONK RAMSEY, C.
2009 "Bayesian Analysis of Radiocarbon Dates", in *Radiocarbon* 51 (2009), pp. 337-360.
BRONK RAMSEY, C. - DEE, M.W. - ROWLAND, J.M. - HIGHAM, T.F.G. - HARRIS, S.A. - BROCK, F. - QUILES, A. - WILD, E.M. - MARCUS, E. - SHORTLAND, A.J.
2010 "Radiocarbon-based Chronology for Dynastic Egypt", in *Science* 328 (5985) (2010), pp. 1554-1557.
BRUINS, H.J. - MACGILLIVRAY, A. - SYNOLAKIS, C.E. - BENJAMINI, C. - KELLER, J. - KISCH, H.J. - KLÜGEL, A. - VAN DER PFLICHT, J.
2008 "Geoarchaeological tsunami deposits at Palaikastro (Crete) and the Late Minoan IA eruption of Santorini", in *Journal of Archaeological Science* 35 (2008), pp. 191-212.
BRUINS, H.J. - VAN DER PFLICHT, J. - MACGILLIVRAY, A.
2009 "The Santorini eruption and tsunami deposit in Palaikastro (Crete): dating by geology, archaeology, 14C, and Egyptian chronology", in *Radiocarbon* 51 (2009), pp. 397-411.
BRYAN, B.M.
1991 *The reign of Thutmose IV*, Baltimore 1991.
BRYAN, S.E. - COOK, A.G. - EVANS, J.P. - HEBDEN, K. - HURREY, L. - COLLS, P. - JELL, J.S. - WEATHERLEY, D. - FIRN, J.
2012 "Rapid, Long-Distance Dispersal by Pumice Rafting", in *Plos One* 7 (2012), pp. 1-13.
DAVIS, E.N.
1990 "A Storm in Egypt during the Reign of Ahmose", in D.A. HARDY (ed.), *Thera and the Aegean World III: Proceedings of the Third International Congress, Santorini, Greece, 3-9 September, 1989*, London 1990, pp. 232-235.
DEE, M.W. - BROCK, F. - HARRIS, S.A. - BRONK RAMSEY, C. - SHORTLAND, A.J. - HIGHAM, T.F.G. - ROWLAND, J.M.
2010 "Investigating the likelihood of a reservoir offset in the radiocarbon record for ancient Egypt", in *Journal of Archaeological Science* 37 (2010), pp. 687-693.
VAN DIJK, J.
2008 "New Evidence on the Length of the Reign of Horemheb", in *JARCE* 44 (2008), pp. 193-200.
ERICHSEN, W.
1954 *Demotisches Glossar*, Kopenhagen 1954.
ERMAN, A. - GRAPOW, H.
1957 *Wörterbuch der ägyptischen Sprache* (Deutsche Akademie der Wissenschaften zu Berlin; Vorträge und Schriften) (2nd edition), Berlin - Leipzig 1957.
FOSTER, K. - RITNER, R.K.
1996 "Texts, Storms, and the Thera Eruption", in *Journal of Near Eastern Studies* 55 (1996), pp. 1-14.
FOSTER, K. - STEBRA, J. H. - STEINHAUSER, G. - BICHLER, M.
2009 "The Thera eruption and Egypt: pumice, texts and chronology", in D. WARBURTON (ed.), *Time's up! Dating the Minoan eruption of Santorini* (Monographs of the Danish Institute of Athens 10), Athens 2009, pp. 171-180.

FRIEDRICH, W.L. - KROMER, B. - FRIEDRICH, M. - HEINEMEIER, J. - PFEIFFER, T. - TALAMO, S.
2006a "Santorini Eruption Radiocarbon Dated to 1627 - 1600 B.C.", in *Science* 312 (5773) (2006), p. 548.
2006b "Supporting Online Material for Santorini Eruption Radiocarbon Dates to 1627-1600 B.C.", in *Science* 312 (2006), pp. 1-5, online at: www.sciencemag.org/cgi/content/full/312/5773/548/DC1.
2009 "Santorini Eruption Radiocarbon Dated to 1627-1600 BC: Further Discussion", in S.W. MANNING - M.J. BRUCE (eds.), *Tree-Rings, Kings, and Old World Archaeology and Environment*, Oxford - Oakville 2009, pp. 293-298.

GOEDICKE, H.
1992 "The Chronology of the Thera/Santorini Explosion", in *Ägypten und Levante* 3 (1992), pp. 57-62.

GOYON, G.
1936 "Les travaux de Chou et les tribulations de Geb d'après le naos 2248 d'Ismalia", in *Kemi* 6 (1936), pp. 1-42, pls. 1-5.

GRIFFITH, F.L.
1890 *The Antiquities of Tell El Yahûdîya* (Egypt Exploration Fund Memoire 7), London 1890.

HELCK, W.
1983 *Historisch-Biographische Texte der 2. Zwischenzeit und neue Texte der 18. Dynastie*, 2nd edition (Kleine ägyptische Texte 5.2), Wiesbaden 1983.

HÖFLMAYER, F.
2012 "The Date of the Minoan Santorini Eruption: Quantifying the 'Offset' ", in *Radiocarbon* 54 (2012), pp. 435-448.

HORNUNG, E. - KRAUSS, R. - WARBURTON, D. (eds.)
2006 *Ancient Egyptian Chronology* (Handbook of Oriental Studies. Section 1, the Near and Middle East, Vol. 83), Leiden - Boston 2006.

JAMES, P.
2012 "Review article: Tree-Rings, Kings and Old World Archaeology and Environment", in *Palestine Exploration Quarterly* 144 (2011), pp. 78-84.

KITCHEN, K.A.
2006 "The Strengths and Weaknesses of Egyptian Chronology - A Reconsideration", in *Ägypten und Levante* 16 (2006), pp. 293-308.
2007 "Egyptian and Related Chronologies - Look, no sciences, no Pots!", in M. BIETAK (ed.), *The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. III* (Contributions to the Chronology of the Eastern Mediterranean 9), Vienna 2007, pp. 163-171.

KLUG, A.
2002 *Königliche Stelen in der Zeit von Ahmose bis Amenophis III* (Monumenta Aegyptiaca VIII), Turnhout 2002.

KRAUSS, R.
2003 "Arguments in Favor of a Low Chronology for the Middle and New Kingdom in Egypt", in M. BIETAK (ed.), *The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. II* (Contributions to the Chronology of the Eastern Mediterranean 4), Vienna 2003, pp. 175-197.
2007 "An Egyptian Chronology for Dynasties XIII to XXV", in M. BIETAK (ed.), *The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. III* (Contributions to the Chronology of the Eastern Mediterranean 9), Vienna 2007, pp. 173-189.

KRICHAK, S.O. - TSIDULKO, M. - ALPERT, P.
2000 "November 2, 1994, severe storms in the southeastern Mediterranean", in *Atmospheric Research* 53 (2000), pp. 45-62, online at: http://www.tau.ac.il/~pinhas/papers/2000/krichak.et_al_AR_2000.pdf (last accessed March 13, 2013).

KUTSCHERA, W. - BIETAK, M. - WILD, E.M. - BRONK RAMSEY, C. - DEE, M.W. - GOLSER, R. - KOPETZKY, K. - STADLER, P. - STEIER, P. - THANHEISER, U. -WENINGER, F.
2012 "The chronology of Tell el-Dab^{c}a: A crucial meeting point of the 14C dating, archaeology and Egyptology in the 2nd millennium BC", in *Radiocarbon* 54 (2012), pp. 407-422.

LACAU, P.
1909 *Stèles du Nouvel Empire* (Catalogue Général des Antiquités Égyptiennes du Musée du Caire), Cairo 1909.

LUFT, U.
2003 "Priorities in Absolute Chronology", in M. BIETAK (ed.), *The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. II* (Contributions to the Chronology of the Eastern Mediterranean 4), Vienna 2003, pp. 199-204.

MANNING, S.W.
1999 *A test of time: the volcano of Thera and the chronology and history of the Aegean and east Mediterranean in the mid second millenium BC*, Oxford 1999.

MANNING, S.W. - BRONK RAMSEY, C. - KUTSCHERA, W. - HIGHAM, T. - KROMER, B. - STEIER, P. - WILD, E.M.
2006 "Chronology for the Aegean Late Bronze Age 1700-1400 B.C.", in *Science* 312 (5773) (2006), pp. 565-569.

MANNING, S.W. - SEWELL, D.A.
2002 "Volcanoes and history: a significant relationship? The case of Santorini", in R. TORRENCE - J. GRATTAN (eds.), *Natural Disasters and Cultural Change* (One world archaeology 45), London - New York 2002, pp. 264-291.

MCCOY, F.
2009 "The eruption within the debate about the date", in D. WARBURTON (ed.), *Time's up! Dating the Minoan eruption of Santorini* (Monographs of the Danish Institute of Athens 10), Athens 2009, pp. 73-90.

MOELLER, N. - MAROUARD, G. - AYERS, N.
2012 "Discussion of late Middle Kingdom and early Second Intermediate Period history and chronology in relation to the Khayan sealings discovered at Tell Edfu", in *Ägypten und Levante* 21 (2012), pp. 87-121.

MÜLLER, V.
2006 "Wie gut fixiert ist die Chronologie des Neuen Reiches wirklich?", in *Ägypten und Levante* 16 (2006), pp. 203-230.

MURPHY, K.
1994a "226 Killed as Floods, Fire Ravage Egyptian Towns", in *Los Angeles Times*, November 3 (1994), online at: http://articles.latimes.com/1994-11-03/news/mn-58298_1_death-toll (last accessed March 13, 2013).
1994b "New Flooding in Egypt Threatens Historic Tombs", in *Los Angeles Times*, November 5 (1994), online at: http://articles.latimes.com/keyword/floods-egypt (last accessed March 13, 2013).

POULAIN, P.-M. - MENNA, M. - MAURI, E.
2012 "Surface Geostrophic Circulation of the Mediterranean Sea Derived from Drifter and Satellite Altimeter Data", in *Journal of Physical Oceanography* 42 (2012), pp. 973-990.
RITNER, R.K. - MOELLER, N.
in press "The Ahmose 'Tempest Stela', Thera and Comparative Chronology", in *Journal of Near Eastern Studies* (in press).
RYHOLT, K.S.B.
1997 *The Political Situation in Egypt during the Second Intermediate Period c. 1800-1550 B.C.* (Carsten Niebuhr Institute Publications 20), Copenhagen 1997.
SCHNEIDER, T.
1998 "Mythos und Zeitgeschichte in der 30. Dynastie. Eine politische Lektüre des 'Mythos von den Götterkönigen' ", in A. BRODBECK (ed.), *Ein ägyptisches Glasperlenspiel: ägyptologische Beiträge für Erik Hornung aus seinem Schülerkreis*, Berlin 1998, pp. 207-242.
2008 "Das Ende der kurzen Chronologie: Eine kritische Bilanz der Debatte zur absoluten Datierung des Mittleren Reiches und der Zweiten Zwischenzeit", in *Ägypten und Levante* 18 (2008), pp. 275-315.
2010 "A Theophany of Seth-Baal in the Tempest Stela", in *Ägypten und Levante* 20 (2010), pp. 405- 409.
SHAW, I.
2000 *The Oxford History of Ancient Egypt*, Oxford 2000.
STERBA, J. H. - FOSTER, K. - STEINHAUSER, G. - BICHLER, M.
2009 "New light on old pumice: the origins of Mediterranean volcanic material from ancient Egypt", in *Journal of Archaeological Science* 36 (2009), pp. 1738-1744.
VANDERSLEYEN, C.
1967 "Une tempête sous le règne d'Amosis", in *Revue d'Égyptologie* 19 (1967), pp. 123-159.
1968 "Deux nouveaux fragments de la stèle d'Amosis relatant une tempête", in *Revue d'Égyptologie* 20 (1968), pp. 127-134.
VERHOEVEN, U.
1991 "Eine Vergewaltigung? Vom Umgang mit einer Textstelle des Naos von El Arish", in U. VERHOEVEN - E. GRAEFE (eds.), *Religion und Philosophie im alten Ägypten. Festgabe für Philippe Derchain zu seinem 65. Geburtstag am 24. Juli 1991* (Orientalia Lovaniensia Analecta 39), Leuven 1991, pp. 319-330.
WIENER, M.H.
2009 "Cold Fusion: The Uneasy Alliance of History and Science", in S. W. MANNING - M. J. BRUCE (eds.), *Tree-Rings, Kings, and Old World Archaeology and Environment*, Oxford - Oakville 2009, pp. 277-292.
WIENER, M.H. - ALLEN, J.P.
1998 "Separate Lives: The Ahmose Tempest Stela and the Theran Eruption", in *Journal of Near Eastern Studies* 57/1 (1998), pp. 1-27.