The southern Levantine earthquake of 418/419 AD and the archaeology of Byzantine Petra

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This article provides a critical review of the archaeological, geological, and historical evidence concerning the southern Levantine earthquake of 418/419 AD, specifically its effects on Petra. Historical accounts indicate that the earthquake caused destruction in Jerusalem and elsewhere, but archaeological evidence is sparse. Numerous destruction layers at sites in the Galilee were attributed to the 418/419 earthquake, but these attributions have all been questioned due to the presence of material in these layers post-dating the early 5th century AD. To the south, the attribution of the destruction of the Spätrömisch II phase at al-Zantur in Petra to this earthquake has largely been accepted. I review the published evidence and determine that this, too, has been dated too early. Based on this evidence, I suggest that the destruction of al-Zantur Spätrömisch II occurred in the 6th century and argue that the 418/419 earthquake was a relatively minor event, affecting primarily the Jerusalem region. This has bearing on the dating of diagnostic artifact types found in this phase, notably the Negev wheel-made lamp, which I argue should be considered a reliable indicator of dates in the 6th–7th century AD. This, in turn, has implications for the dating of other sites, notably the Petra Church.

Keywords: earthquakes; Byzantine southern Levant; Petra; coins; Negev wheel-made lamp; dating

Introduction

This paper began as an evaluation of the evidence for a set of 'early' dates for the Negev wheel-made lamp at al-Zantur and the Petra Church, both in Petra. This initially seemed like a relatively minor 'specialist' issue, but it revealed an interlocking set of circular assumptions underlying the dating of several major Byzantine sites in southern Jordan, ultimately resting on the assumption that Bauphase Spätrömisch II (Ger. 'Construction Phase Late Roman II') at al-Zantur was destroyed in an earthquake in 418/419 AD.

The comprehensive and detailed ceramic reports from al-Zantur have, since their publication, been critical for dating other sites in the Petra region and beyond, particularly due to the very precise dating of many types. This precision has begun to be questioned, however. Erickson-Gini (2010: 101-102; Erickson-Gini and Tuttle 2017: 116-124) has argued that Schmid's (2000) dating of the Nabataean finewares is in many cases far too narrow; for example, she argues on the basis of associated imported finewares that Schmid's Nabataean painted fineware Phase 3b, which he dates to 80-100 AD, not only continues into the late 2nd-early 3rd century but is likely more typical of this later period. Similar scrutiny should be applied to the ceramics from Spätrömisch II, dated to the narrow period between the earthquakes of 363 and 418/419. Because of the relative paucity of well-dated contemporary material, this phase has become the key chronological anchor for the early 5th century in the region. However, the fact that continued excavation in the region, including in Petra, has not identified contemporary destruction layers raises the question of whether the destruction of Spätrömisch II has been misdated.

In this paper, I reexamine the dating of al-Zantur I Spätrömisch II. First, I consider the geological, archaeological, and historical evidence concerning the extent of damage caused by the 418/419 earthquake, and second, I evaluate the published reports of this phase. Based on this, I argue that the end of Spätrömisch II has been dated at least a century too early and argue instead for a 6th century destruction. I then consider the implication of this new dating for several sites on Petra's North Ridge, particularly the Petra Church, and argue that it resolves several long-standing conundra. Although this paper is by no means a comprehensive overview of dating issues in Byzantine southern Jordan, or even of the 418/419 earthquake, I hope it will prompt further

discussion of the assumptions underlying our archaeological dating and understanding of this period.

The earthquake of 418/419 AD

Historical evidence for the 418/419 AD earthquake is limited to a now-lost letter reconstructed from several extant sources. These sources refer to the destruction of Palestinian cities, but mention only Jerusalem specifically, and suggest, probably hyperbolically, that the earthquake led to the mass conversion of Jews and pagans to Christianity (Levenson 2004: 431-432; see also Russell 1985: 42–43). Ambraseys (2009: 162) makes a good historical argument for placing this earthquake in 418 AD, but I refer to the event as the 418/419 earthquake throughout the paper, as 419, the date given by Marcellinus Comes, is commonly used in archaeological reports. The earthquake is listed in most earthquake catalogs for the region, which, on the basis of this limited historical evidence, suggest that it caused damage throughout Palestine (Ambraseys 2009: 162; Amiran *et al.* 1994: 266; Ferry *et al.* 2011: 48; Heck and Davis 1946: 366; Kallner-Amiran 1951: 225; Kovach 1988: 247; Russell 1985: 39, 42-43; Zohar *et al.* 2016: 976, 978, Table 3). Ben-Menahem (1979: 267, 296, Table 1; 1981: 188, Table 1) proposed that the earthquake was a magnitude 6.2 event with an epicenter 'near Safed' (Fig. 1), but, as discussed below, this is unlikely.

The geological evidence is ambiguous. Ken-Tor *et al*. (2001: 2228, 2230–2232), in their study of the paleoseismic record at Ze'elim Terrace, saw no evidence for the 418/419 earthquake in their data, associating Event D with the better-documented 363 earthquake. Agnon *et al*. (2006: 204; see also Agnon 2014: 239), however, argue that Event D should instead be correlated with the 418/419 earthquake. Kagan *et al*. (2011: Table 3) argue the same based on samples taken from a second outcrop at Ze'elim. A

similar problem can be seen in layer 22 of the 'En Gedi core, which Migowski *et al*. (2004: 306, Table 2) correlate with the 418/419 earthquake, rather than 363.

In all the studies discussed above, the occurrence of an earthquake is determined by the identification of a seismite: a sedimentary layer deformed by seismic activity. While Ken-Tor *et al.* (2001: 2226-2227, 2230) directly radiocarbon dated some of the seismites in the Ze'elim Terrace core, in other cases, including Event D, no radiocarbon samples could be obtained from the seismite itself. In these cases, the date was instead determined using an estimated rate of deposition between two radiocarbon samples. For Event D, a radiocarbon sample taken not far below the seismite[2] produced a calibrated 2σ date of 265–550 AD, while the next sample above[3] produced a calibrated 2σ date of 1030-1210 AD (Ken-Tor *et al.* 2001: 2225, Table 1; see recalibrated dates in footnotes below). By assuming a sedimentation rate of 4–9 mm per year, Ken-Tor *et al.* (2001: 2230-2231) arrive at an age range of 358–580 AD for Event D and argue that the 363 earthquake provides the best historical match. Agnon *et al*. (2006: 204) instead assume a narrower sedimentation rate of 5–6 mm per year, which, they argue, more likely correlates with the 418/419 earthquake. Kagan *et al*. (2011: Table 3) instead apply a Bayesian depositional model (see Bronk Ramsey 2008) to a different series of radiocarbon samples from a second outcrop at Ze'elim Terrace and arrive at a modeled 2σ date of 370–541 AD for the event. It is worth noting, however, that a radiocarbon

[2] KIA3220, 1630 ± 40 BP, 407–535 cal. AD (1σ), 265–547 cal. AD (2σ). Recalibrated by the author using IntCal20 (Reimer *et al.* 2020) with OxCal 4.4 (Bronk Ramsey 2009). The IntCal20 calibrated date is substantially different from the 2σ range of 340–540 reported by Ken-Tor *et al.* (2001: 2225, Table 1). While the 1σ range better supports an attribution to the 418/419 earthquake, the models discussed above use the 2σ ranges.

[3] KIA8258, 909 ± 23 BP, 1048–1203 cal. AD (1σ), 1042–1214 cal. AD (2σ). Recalibrated by the author using IntCal20 (Reimer *et al.* 2020) with OxCal 4.4 (Bronk Ramsey 2009).

sample[4] taken 4 cm below this seismite produced a calibrated 2σ date of 249–531 AD, which certainly does not rule out a correlation to the 363 earthquake. Migowski *et al.* (2004: 303) arrive at a date of 418/419 AD for layer 22 of the 'En Gedi core by counting laminated sediment layers, which they hypothesize were deposited annually, and comparing these to a series of radiocarbon dates.

The accuracy of the dating of these seismites is, therefore, quite dependent on estimates of the rate and variability of sediment deposition. While it is reasonable and desirable to try to constrain the dates of seismites using these methods, it is important to recognize that the available radiocarbon dates do not rule out a correlation with the 363 earthquake. At both sites, it seems implausible that there would be no evidence of the well-documented and widely destructive 363 earthquake (see Russell 1980), but there would be evidence of the 418/419 earthquake, which Agnon (2014: 239) admits was 'likely a local moderate event' (see also Leroy *et al.* 2010: 194). Agnon *et al.* (2006: 212) suggest that 'brecciation from an earthquake that succeeds another strong earthquake might obliterate the breccia layer of the predecessor.' This may be the case, but demonstrating this requires additional evidence for a strong earthquake in 418/419.

Misidentification may also be a factor. At 'En Gedi, it is probable that event 22 should be correlated with the 363 earthquake, while event 21, attributed to the Acre earthquake of 502 (see Ambraseys 2009: 179), more likely correlates with the 418/419 earthquake (Migowski *et al.* 2004: 306, Table 2). Seismites correlating to both the 363 and 418/419 earthquakes were also identified in a section at 'En Feshkha, on the northwestern side of the Dead Sea (Kagan *et al.* 2011: Table 3), *c*. 20 km east-southeast

[4] RTT5186, 1685 ± 40 BP, 263–417 cal. AD (1σ), 249–531 cal. AD (2σ). Recalibrated by the author using IntCal20 (Reimer *et al.* 2020) with OxCal 4.4 (Bronk Ramsey 2009).

of Jerusalem.[5] Strangely, neither event seems to be evident in the Nahal Darga fan-delta sequence (Enzel *et al*. 2000), *c.* 15 km north of 'En Gedi.

The archaeological evidence

The Galilean synagogues

418/419 earthquake destructions have been suggested for a number of synagogues in the Galilee, including Synagogue II at Khirbat Shama' (Meyers *et al*. 1976: 38, 258), Khirbat Wadi Hamam (Leibner and Arubas 2018: 97), Chorazin (Russell 1980: 61, n. 5; 1985: 43), and the Stratum IIa synagogue at Hammath Tiberias. In a series of articles and book chapters, Jodi Magness (1997: 217–218; 2005: 8–10; 2007: 271–272; 2012: 113–114) demonstrates that these destructions have all been misdated. While the excavators generally cite an absence of late 5th and 6th century coinage as evidence for destruction in 418/419, Magness argues that the presence of Late Roman D (LRD) Forms 2 and 9 and Phocaean Red Slip (PRS) Ware Form 3 at these sites indicates continuity into the late 5th or 6th century. If these destructions cannot be attributed to the 418/419 earthquake, an epicenter near Safed, as suggested by Ben-Menahem (1979), is unlikely.

Afeq-Antipatris

Kochavi (1975: 40; 1976: 52; 1977: 55; 1981: 84), citing numismatic and ceramic evidence, claimed that Afeq-Antipatris was destroyed in the 418/419 earthquake, and was not rebuilt until 'the end of the Byzantine period.' The presence of 'tilted and

[5] Kagan *et al.* (2011: 11) also argue that seismites correlated with the Beirut earthquake of 551 are found at Ze'elim Terrace, 'En Gedi, and 'En Feshkha. A correlation with the late 6th century Areopolis earthquake, discussed below, is more probable (Rucker and Niemi 2010).

distorted walls and subsided arches' (Karcz and Kafri 1978: 244, Fig. 6, 245) does seem to indicate earthquake damage, but it is not clear why this was attributed to the 418/419 earthquake. Harvard Syriac 99 refers to the destruction of 'the whole of Antipatris' in the 363 earthquake, after which it was rebuilt, although an account dating to 404 refers to it as 'half-ruined' (Brock 1977: 276; Frankel and Kochavi 2000: 23, 31; Russell 1980: 51, Fig. 4; 1985: 42). Indeed, in a more recent excavation, Golan (2008) places the destruction of the southern cardo in 363 on numismatic grounds and suggests the city was abandoned afterwards.

Caution must be exercised in interpreting the numismatic data, however, as the ceramic finds included PRS 3 forms dating to the mid-5th–6th century (Golan 2008: Fig. 5.5-6). More troubling is the apparent presence of 'Mefjar ware' (i.e. Islamic Cream Ware), which dates no earlier than the late 7th century (see Walmsley 2001), in the 'earthquake stratum' (Neidinger 1982: 167). This may indicate multiple destructions, but without more complete publication of the excavations, this is difficult to evaluate. It is, however, worth noting the presence of a bishop of Antipatris at the Council of Chalcedon in 451 (Dauphin 2000; Frankel and Kochavi 2000: 23, 31). This may be explained, as Fischer (1989: 1806) suggests, by assuming that the role of Antipatris 'was filled with a great number of smaller settlements' like Khirbat Dhikrin (Zikrin) after the 418/419 earthquake, but it is equally likely that Antipatris was simply not abandoned in the early 5th century.

Oboda

Erickson-Gini (2010: 80) argues, on the basis of numismatic and ceramic finds from excavations in the Late Roman/Early Byzantine Quarter, that Oboda ('Avdat), in the Negev Highlands, was destroyed in an early 5th century earthquake. Rather than attributing this to the 418/419 earthquake, however, she suggests 'a local event similar

to the one originating in the Nafha rift [south of the site] that destroyed the town in the early seventh century' (Erickson-Gini 2010: 80; on the later event, see Ambraseys 2009: 219–220; Korjenkov and Mazor 1999). It is unclear how this destruction should be interpreted. Some rooms in the Late Roman/Early Byzantine Quarter appear to have been damaged in the 363 earthquake and collapsed again in the early 5th century, suggesting that the collapse may not be due to the intensity of the later earthquake, as Erickson-Gini (2010: 93–95) suggests, but to the quality of the late 4th century repairs. Regardless, the event does not seem to have caused widespread destruction, even at other Negev Highlands sites.

Jerusalem

As discussed above, Jerusalem is the only place mentioned specifically in the historical sources for the 418/419 earthquake, but published archaeological evidence of this destruction is essentially nonexistent. There are two primary reasons for this. First, while historical sources for the 5th century are plentiful, archaeological contexts dated to the 5th century are rare, due to the difficulty of identifying the ceramics and coins of this period (Avner 2007). Second, it is likely that, in Jerusalem, 'earthquake-damaged walls were always either repaired or cleared away to make room for subsequent construction' (Nur 2008: 113-114). Evidence for earthquakes, therefore, often comes from repairs. It would be difficult, however, to distinguish between repairs to damage from the 363 and 418/419 earthquakes, and this is complicated by the historically documented mid-5th century repair and expansion of Jerusalem's city walls by the Empress Eudocia (Avner 2007: 196-198). As such, it is not currently possible to determine the extent of destruction the earthquake caused in Jerusalem.

Coins and dating

In virtually all the examples discussed above, destruction layers have been attributed to the 418/419 earthquake based primarily on numismatic evidence. Because coins are often the most precisely datable artifacts found during excavations, it is tempting to assume both that they provide the best dates for a context and that a destruction layer will be close in age to the latest coins found in it. Unfortunately, the processes through which coins enter the archaeological record complicate these assumptions. As Lockyear (2012: 197) notes, 'coins do not break and can remain in use for considerable periods of time. The amount of time, however, varies greatly and is dependent on monetary history, i.e. the details of minting, debasement, reform, restriking and supply.' Interpreting the significance of coin frequencies at any site, therefore, requires understanding 'the cumulative interaction of coins minted plus coinage supply plus coin use plus coins lost plus coin recovery' (Lockyear 2012: 207-208). Coin frequencies, in other words, are not straightforward indicators of settlement intensity.

Safrai (1998: 5-25, 130, see also 170-205, Figs. 12-67) argues that few coins of any century were in circulation in the Eastern Mediterranean in the 5th century, indicating a decline of the economy, and probably of settlement, as well. Bijovsky (2000-2002: 207-209; 2012: 165-169), however, demonstrates that 4th century coins continued to circulate in the 5th and perhaps even early 6th centuries, that many unidentifiable small coins dated to the 4th–5th century should be placed in the 5th, and that the decrease in 5th century coinage should be understood in terms of a 'dramatic increase' of minting in the last three quarters of the 4th century, which saw rates 6.5 times higher than in the following three centuries. Given this, a decrease or even lack of identifiable 5th century coinage at a site cannot be taken as evidence for absence of settlement in that period.

Did the 418/419 earthquake happen?

Given the lack of archaeological evidence, it is reasonable to ask whether the earthquake of 418/419 actually occurred. Historical evidence for the 418/419 earthquake is limited to four sources, all of which seem to draw on a now-lost letter written by the bishop of Jerusalem (Levenson 2004: 431-432). One of these sources, Marcellinus Comes, refers to the destruction of "[m]any towns and villages in Palestine," and a number of other sources refer to shaking being felt in Jerusalem, but no other place is mentioned by name (Ambraseys 2009: 162; Russell 1985: 42-43). While Marcellinus Comes might be taken as evidence that the earthquake caused widespread destruction, it is, nonetheless, the case that there is no specific historical evidence for damage anywhere other than Jerusalem.

As noted above, much of the geological evidence for the 418/419 earthquake seems, in light of the historical and archaeological evidence, to be a better match for the 363 earthquake, particularly given the uncertainty involved in calculating the date of seismites (*contra* Migowski *et al*. 2004). Seismites associated with both events were found only at 'En Feshkha (Kagan *et al*. 2011: Table 3) and possibly 'En Gedi (Migowski *et al.* 2004: 306, Table 2). These sites provide limited evidence that the 418/419 earthquake did happen.

Taken together, the historical and geological evidence suggest that there probably was an earthquake in 418/419 AD. Its effects, however, were limited. I suggest that the evidence discussed above indicates damage limited to a relatively small region surrounding Jerusalem, perhaps extending as far south as 'En Gedi. Considering this, the evidence for the dating of contexts associated with the 418/419 earthquake in Petra deserves closer scrutiny.

Petra

Within Petra, the 418/419 earthquake has been suggested as the cause for the destruction of three structures: al-Zantur I, specifically the end of Bauphase Spätrömisch II; one of the structures outside of the Urn Tomb, House II; and North-Eastern Petra Project (NEPP) Structure I (Fig. 2). At the Urn Tomb, a 363 earthquake destruction has been suggested for a cave below the tomb (Zayadine 1974: 138) as well as House II, which was partially rebuilt afterwards and by the 6th century was being 'used as a quarry' (Zeitler 1993: 256-257). Taking this quarrying as evidence for a 5th century abandonment of House II, Kolb (2000: 230; 2007: 154-155) suggests a second destruction in the 418/419 earthquake, primarily based on analogy to al-Zantur I. As only a preliminary report has appeared for House II, it is not possible to evaluate the archaeological evidence for this attribution, but a 5th century abandonment of House II may instead be related to the modification of the Urn Tomb for use as a church in 446 (Bikai 2002: 271).

NEPP Structure I has not been excavated, and the claim that it was destroyed in the 418/419 earthquake is based on surface finds and reference to al-Zantur I (Fiema and Schmid 2014: 431). Without excavation, the actual date and nature of the building's destruction remain uncertain. The claim for damage at Petra related to the 418/419 earthquake therefore rests primarily on the evidence from al-Zantur I.

Kolb (1996: 51, 89; 2000: 238, 244; 2007: 157) attributes the destruction of the final occupation phase of al-Zantur I, Spätrömisch II, to the 418/419 earthquake. As with many of the sites discussed above, this attribution is based primarily on numismatic finds, which decline sharply after the 4th century. Like most other regions of the Eastern Mediterranean, however, a lack of 5th century coinage is typical for sites in southern Jordan. For example, in their discussion of coins collected (and purchased) in

Faynan, Kind *et al.* (2005: 188) note a decline in coin frequencies after about 420 AD. While this does not rule out an earthquake, many sites that seem to lack 5th century coinage were, on close inspection, occupied during the 5th century.

The discussion of the coin finds at al-Zantur I also gives cause for pause. The author states,

> An end of the settlement of ez Zantur after the earthquake of 419 AD could be harmonized well with the coin series, if not for the discovery of a small bronze coin of Marcianus, which was minted in the years 450–457 AD, discovered in the ash layer of Room 28, in the immediate vicinity of the remains of a kitchen inventory destroyed in an earthquake. (Peter 1996: 92, my translation)

Peter goes on to point out that, as the only mid-5th century coin at the site, it may be intrusive, which would allow for an earthquake destruction of Spätrömisch II in 418/419. It is worth noting, however, the presence of 25 unidentifiable small bronze coins, 15 of which could be dated to the 4th–5th century (Peter 1996: 98-100, nos. 89-113). At least some of these are likely to be issues of the 5th century.

The discussion of the ceramic assemblage follows a similar pattern. The latest imports present in Spätrömisch II are African Red Slip Ware (ARS) Forms 91C and 93B, both dated by Hayes (1972: 144, 148) to the 6th century (Schneider 1996: 40). Schneider (1996: 41) argues that Hayes's (1972) dating for the southern Levant is not entirely secure, and the presence of these forms in Spätrömisch II is evidence for an early 5th century appearance. At production sites in Tunisia, however, neither form appears before the mid-5th century (Mackensen and Schneider 2002: 127-130). Likewise, Form 93 does not appear in Carthage until the 5th century, and first appears at

Karanis, in the Fayyum, in the '420s C.E. or later' (Pollard 1998: 150). It is very unlikely that these forms appeared at al-Zantur earlier than in North Africa.

The 'local' ceramic assemblage from Spätrömisch II also contains several forms that postdate 419. Of note are several 'Aqaba amphorae (Fellman Brogli 1996: 255, Abb. 766-767), which date no earlier than the early 5th century (Parker 2013: 741); Magness's (1993: 206) Arched-Rim Basin Form 2, dating to the 6th–7th century (Fellman Brogli 1996: 260, Abb. 790); and local interpretations of late 5th–6th century ARS, e.g. Forms 84 and 99 (Fellman Brogli 1996: 263, Abb. 809–810). Gerber (2001: 361–362) also notes the similarity of the Spätrömisch II ceramics to those apparently from 6th century phases at the Petra Church, although these contexts are not secure enough to make this comparison definitive.

Overall, the argument that Spätrömisch II was destroyed in the 418/419 earthquake is rather circular. A lack of 5th century coinage is presented as evidence of this destruction, and this in turn is used to dismiss a mid-5th century coin as intrusive. If this is accepted, an earlier date must also be accepted for the otherwise mid-5th–6th century ceramics. When considering the evidence together, however, the more parsimonious explanation is that al-Zantur I was occupied, perhaps on a small scale or even intermittently, into the 6th century, which would bring al-Zantur I into line with other sites in Petra and the broader region with 363 and (late) 6th century destruction layers (see Table 1).

If an earthquake did cause the destruction of Spätrömisch II, the best candidate would seem to be the Areopolis earthquake of ca. 597 AD. This event is known primarily from an inscription that describes repairs performed in the year 492 of the calendar of the province of Arabia (597/8 AD) following an earthquake, found by Zayadine (1971) at al-Rabba (ancient Areopolis), on the Karak Plateau (see also

Ambraseys 2009: 216-217).[6] Rucker and Niemi (2010: 101-103) have argued, primarily on the basis of the continued use of the Petra Church into the last decade of the 6th century, as evidenced by the Petra Papyri, that this earthquake is a better fit for the 6th century destructions in Petra previously attributed to the earthquake of 551.

Accepting ca. 597 as the date of the destruction of Spätrömisch II is not critical to my argument, but it follows from accepting the excavators' identification of an earthquake destruction and considering the events postdating 418/419 that could plausibly have affected southern Jordan. The possible events listed in the most recent Ambraseys (2009: 179, 199–203, 216–217) catalog are the 502 Acre earthquake, which seems to have caused little damage inland; the 551 Beirut earthquake, an attribution Ambraseys explicitly rejects due to the lack of major destruction in Jerusalem; and the ca. 597 Areopolis earthquake, which is the most likely possibility if the first two are ruled out. Of course, it is not possible to rule out destruction in a later earthquake, an otherwise unknown earthquake, or due to another cause entirely. Likewise, the destruction of the building does not necessarily coincide with the end of the occupation; it is entirely possible for an earthquake to destroy a previously abandoned building. Regardless of the exact date of the destruction, the evidence discussed above indicates that occupation continued into the 6th century.

The ceramics from al-Zantur are an important chronological anchor in the Petra region, and it has generally been accepted that those from Spätrömisch II date to the narrow period between 363 and 419. Expanding the dating of this phase to the late 4th–

[6] The text of the inscription, as translated in Ambraseys (2009: 217), reads: "During the incumbency of the most holy bishop John, […] was restored in the year 492 after the earthquake" (original in Zayadine 1971: 139).

6th century, therefore, has implications for the dating of other sites in Petra, notably the Petra Church.

The Petra Church

At the Petra Church, excavators identified eight phases (Phases III-X) dating to the 4th–7th century (Fiema 2001a). Phase III was identified as a residential complex, and dated to the Early Byzantine period, between the 363 earthquake and the mid-5th century. At the beginning of Phase IV, dated to the mid-5th century, a mono-apsidal church with square *pastophoria* to the north and south of the apse was built. In Phase V, dated to the early 6th century, a number of modifications to the church were undertaken, most importantly the conversion of the *pastophoria* into apses, and, by extension, the modification of the original mono-apsidal plan to a tri-apsidal one. Following this, the excavators identified two late 6th century phases (VI–VII) prior to the Phase VIII fire, which preserved the Petra Papyri (Fiema 2001a). The latest dated papyrus fragment found in the church provides a *terminus post quem* of 593 AD for Phase VIII (Caldwell and Gagos 2007: 427). This date may indicate a connection between the fire and the Areopolis earthquake. An Arabic inscription with diacritical marks may push the date of the fire into the 7th century, as the earliest extant dated inscription with diacritics dates to 642 AD, but Al-Ghul (2004) argues that a late 6th century date is plausible. Phase IX, which followed the fire, is a 'Non-ecclesiastical Occupation' possibly related to modifications that began in Phase VII and is dated 'end of the 6th to mid–[?] 7th century A.D.' (Fiema 2001a: 437). This phase ended with the Phase X earthquake destruction, either in the 7th century (Fiema 2001b: 111) or 748/749 (Bikai and Perry 2012: 96).

Of particular interest for the present argument are Phases III–V, the Byzantine residential occupation and the first two church phases. The dating of the end of Phase III is dependent on the mid-5th century dating of the beginning of Phase IV. This, in

turn, is based primarily on the early 6th century dating of Phase V—the conversion of the church from mono-apsidal to tri-apsidal—following the dating of similar modifications at several churches in the Negev (Fiema 2001b: 53, 77, 120-121). A mid-5th century date for the beginning of Phase IV, however, requires one to ignore evidence for a later date, including a *nummus* from the reign of Justinian I and another *nummus* dating to the last decade of the 5th century at the earliest, both found in the foundation trench of Wall A, the church's southern wall (Betlyon 2001: 388; Fiema 2001b: 31). Fiema (2001b: 53), in discussing the dating of Phase IV, argues that 'the presence of a few sherds or one coin dated later than the 5th century in contexts relevant for the dating of the church, which are otherwise predominantly of 5th century, should not prejudice the general dating.' Given that contamination was evidently common in the foundation trench soundings (Fiema 2001b: 31), this is a reasonable caution, but it should not necessarily be assumed that this later material is the result of intrusion or contamination, either.

Unfortunately, only a small selection of the ceramic material was published (Gerber 2001), which makes reviewing the ceramics from specific contexts difficult. Nonetheless, it must be noted that the 4th–5th century ceramic types at the Petra Church, particularly those from Phase III, were dated primarily by comparison to the ceramics from al-Zantur (Gerber 2001: 361-364). For example, Gerber (2001: 362) notes that a casserole type found in Phase III is found in 6th–7th century contexts at other sites in Jordan, but, based on the similarity of the fabric to examples from al-Zantur I Spätrömisch II, she dates the Phase III examples to the 4th or early 5th century. If Spätrömisch II continued into the 6th century, however, a later date for the casseroles in Phase III is also possible. This is not to suggest that all of the relevant ceramics should be dated to the 6th century, but rather that if al-Zantur I Spätrömisch II was the primary

point of comparison, the assertion that this material is 'predominantly' 5th century (Fiema 2001b: 53) cannot be taken as a certainty, and the later material should not be assumed to be intrusive.

With this in mind, I suggest a different chronology for the Petra Church. If the numismatic evidence is accepted as providing a *terminus post quem* for the construction of Wall A, then the Phase IV construction of the church and, by extension, the end of Phase III, should be placed in the second quarter of the 6th century, rather than the mid-5th. This would also have implications for the dating of Phase III (the first ecclesiastical use) of the Blue Chapel, ca. 50 m north of the Petra Church, which was difficult to date on the basis of archaeological evidence and was dated to the mid-5th century primarily on the basis of the dating of Phase IV at the Petra Church and Phase 2 (sitewide Phase VI) of the church on Jabal Harun (Perry 2020: 52, 58-59). The dating of the Jabal Harun church is based on the presence of early 5th century material in Phase 1 contexts, mid-5th–mid-6th century material in Phase 2, and comparison to other churches, including the Petra Church (Mikkola *et al.* 2008: 102–103, 116–117). The dating of 4th–early 5th century ceramics at Jabal Harun also relied primarily on comparison to al-Zantur I Spätrömisch II, and it is interesting to note that the local Phase VI ceramics from the monastery are dated to the 5th–6th century, while the imported ARS and LRD forms in the same phase date entirely to the 6th century (Gerber 2008: 287; 2016: 130, 132, 153). This is not to suggest that all these phases *must* date to the 6th century (and, indeed, these constructions may not have been entirely contemporary), but accepting a later end for al-Zantur I Spätrömisch II makes the generally accepted mid-5th century date of these constructions less secure, and, particularly in the case of the Petra Church, requires consideration of a 6th century date.

This proposal may also resolve a dating conundrum identified by Gerber (2008: 290), who points out that accepting a late 6th century date for some 'unfamiliar' types at Jabal Harun raises the question, 'where is the late 5th and 6th century material?' While Gerber's (2008: 290; 2016: 159) suggestion that it may be present in Trench R is at least partially borne out by the publication of that material, it is also possible that some ceramics of this period are hiding in plain sight, their dates having been artificially constrained to the early 5th century through comparison to al-Zantur.

This later dating of Phase IV would place the Phase V modifications to the church in the mid-6th century at the earliest, rather than the early 6th century. It is worth noting, in connection to this, the presence of 'very few early 7th century sherds' in the fill of the Phase V bema, which Fiema (2001b: 57) interprets as intrusive. These sherds are not discussed in detail, so the dating cannot be evaluated, but considering the continuity between late 6th and early 7th century ceramics in southern Jordan, e.g. Jabal Harun Phase IX (Gerber 2016: 132), these may in fact be consistent with a later 6th century date. This proposal also finds support in the mid-6th century date recently proposed on the basis of radiocarbon evidence for the Phase IV mono-apsidal to tri-apsidal conversion of the Blue Chapel, which led the excavators to accept a similar date for the renovations of the Ridge Church and Petra Church (Perry 2020: 59–64). The late 6th century dating of Phases VI and VII would remain largely the same, as would the relatively secure date of Phase VIII, which must postdate 593 AD.

Some discussion of the correlation between the Phase V modifications and similar modifications to churches in the Negev is necessary here. While Fiema (2001b: 120) admits that the transition from mono-apsidal to tri-apsidal churches 'is not precisely dated,' he suggests that the Phase V modifications to the Petra Church were part of a pattern observed in the Negev by Negev (1974; 1989) and Margalit (1989).

According to Negev (1989: 142), mono-apsidal churches were built in the mid-4th–5th century and generally converted to tri-apsidal churches in the early 6th century, while new tri-apsidal churches were constructed during the early 7th century. He based this on excavated churches at Mampsis (Mamshit/Kurnub), Oboda (‘Avdat/‘Abda), Sobata (Shivta/Subayta), Elusa (Halutza/al-Khalasa), and Nessana (Nitzana/‘Awja al-Hafir).

As Margalit (1989: 144) warns, however, a lack of dating evidence ‘makes any attempt at placing this phenomenon into a firm chronological sequence futile.’ The final reports of both Mampsis (Negev 1988) and Oboda (Negev 1997) do not include ceramic reports, and for Oboda, the coin finds are presented in a single-page report submitted in 1958 (Kindler 1997), which makes evaluation of the dating difficult. For Shivta, beyond Rosenthal-Heginbottom’s (1982) architectural analysis, which includes limited dating evidence, only a preliminary report of the North Church excavations has appeared (Margalit 1987), while recent probes in the South Church recovered limited material that could only be broadly dated to the Byzantine period (Tepper *et al*. 2018: 145-147). At Elusa, neither Negev’s (1989: 135) nor Goldfus *et al.*’s (2000: 339) excavations of the East Church produced dating evidence for the first phase, and the second phase could only be dated to the mid-5th–6th century.

The basic pattern does not hold elsewhere in the Negev or southern Jordan, either. Margalit (1989: 150) proposes, based on an architectural survey, that the North Church at Rehovot-in-the-Negev (Khirbat al-Ruhayba) follows the same mono-apsidal to tri-apsidal pattern. The excavators, however, identified a tri-apsidal church built in the mid-5th century, with little modification afterwards (Tsafrir 1988: 26). At Horvat Karkur ‘Illit, a 5th century mono-apsidal church with square *pastophoria* was reconstructed on the same mono-apsidal plan in the mid-6th century (Figueras 2004: 7-8). The mono-apsidal Upper Church at al-Humayma, in southern Jordan, was built in

the 6th or early 7th century (Schick 2013: 299). Urman (2004: 69*-70*, 100*-101*) dated the Central Church at Nessana, a mono-apsidal church with two square *pastophoria*, even later, arguing that the ceramics and glass from below the floor place its construction in the late 7th–early 8th century.

There is, therefore, little evidence for a widespread mono-apsidal to tri-apsidal transition, and no reason to assume that all such modifications were contemporary. Likewise, Mikkola *et al.*'s (2008: 116) statement that '[a]ll monoapsidal churches in the Negev … were built before 500' cannot be accepted. Ovadiah (2005: 374) has argued that 'modifications were specific to a particular church or to the churches of a particular settlement, for which the circumstances demanded their implementation.' In the case of the Petra Church, the published data suggest later dates for both the mono-apsidal phase and its conversion to a tri-apsidal plan than those proposed for the Negev.

The Negev wheel-made lamp

The later dating of al-Zantur I Spätrömisch II and the Petra Church proposed above also has implications for a key indicator of Late Byzantine and Early Islamic settlement in the region: the Negev wheel-made lamp (Fig. 3). This lamp, also referred to as a boot-shaped lamp, sandal lamp, inkwell lamp, and (incorrectly) a 'Persian' or 'Mesopotamian' wheel-made lamp, is a common type in southern Jordan and southern Israel.

The vast majority of published examples date to the 6th and 7th centuries AD, probably continuing into the 8th (a full bibliography of comparanda is beyond the scope of this discussion, but see the bibliographies in Barrett [2020: 364-365], da Costa [2012: 251-252], and Grawehr [2006: 349-351]). Da Costa (2012: 251), however, proposes an emergence in the early 5th century, citing examples in 5th century contexts at al-Zantur I

and the Petra Church, as well as ‘En Boqeq and Upper Zohar, near the Dead Sea, although she acknowledges that the dating of these last two sites is disputed. Indeed, Magness (1999: 192-193, 196-199) has convincingly argued based on the ceramic assemblages in the earliest phases of both sites—both of which include LRD Form 9 and other 6th–7th century types—that both ‘En Boqeq and Upper Zohar were built in the mid-6th century and occupied into the 7th century, which would bring the dating of Negev wheel-made lamps at these sites in line with the majority of comparanda. This leaves the lamps from Petra as the only pre-6th century examples. It is worth noting here that Parker (1997: 583), in a review of the ‘En Boqeq and Upper Zohar publications, mentions ‘similar lamps from Petra associated with the 363 earthquake.’ This refers to the preliminary report of the al-Zantur excavations, as the Late Roman phase had not yet been subdivided and was assumed to have ended entirely in 363 (Stucky 1991: 255-256), and these are, in fact, the same lamps from al-Zantur I that Grawehr (2006: 349-351) dates to the early 5th century, discussed below. More recently, Parker (2006: 350) has questioned this early dating, noting that the type does not appear before the early 6th century at al-Lajjun in central Jordan.

At al-Zantur, 23 Negev wheel-made lamps were found, many of them relatively complete (Grawehr 2006: 349-351). All of these but one—no. 528, which was found in a secondary context near the surface of al-Zantur III and, as Grawehr (2006: 350) notes, is not relevant to the present discussion of dating—were found in al-Zantur I Spätrömisch II. Grawehr (2006: 349-350) justifies an early 5th century date by reference to examples from ‘En Boqeq and the Petra Church, but this early date is only necessary if the destruction of Spätrömisch II is dated to 418/419 AD. If this attribution is not accepted, the lamps instead provide additional evidence for a 6th century date.

This leaves only the examples from the Petra Church. The more complete of the two examples found at the site (no. 16) came from a Phase V cistern fill, dating to the 6th century, typical for the type (Fiema 2001b: 71; Khairy 2001: 369). The second (no. 13, a nozzle) was found in a context given in the report as 'Area III, locus 13C, sounding 30.' Khairy (2001: 369) suggests a 'transitional' Late Byzantine-Early Islamic date (i.e. late 6th–7th century), but Grawehr (2006: 350) places it in the 5th century, noting that the sherd was found in a Phase III foundation trench of Wall I. Regarding this context, Fiema (2001b: 23) states, 'The ceramics were overwhelmingly from the 1st through 4th centuries A.D., with the 3d–4th century types most common, although a few of what may be early 5th century sherds were found, too. A coin in II.13C is dated to A.D. 350–55.'[10]

Accepting an early 5th century date for this sherd seems to be the least reasonable interpretation, as it is both in disagreement with the excavators' dating of the context and a full century earlier than the emergence of the type at any other site. Given that contamination was a known problem in the foundation trench soundings (Fiema 2001b: 31), it is also possible that the nozzle belongs to a 6th century lamp but was found in a late 4th century context due either to intrusion or contamination. Finally, it may be the case that Wall I has been misdated, and its construction should be placed in the early 6th century. This need not, however, change the dating of Phase III. Fiema (2001b: 23) noted the 'composite origins of the south wall for Room II,' of which Wall I is part. It is, therefore, possible that Wall I represents an addition to the residential

[10] It should perhaps be noted that Khairy (2001: 369) gives the context as Area III, while Fiema (2001b: 23) instead gives it as Area II. It is quite likely that one of these is a typo, and both are references to the same context, but the discrepancy further adds to the uncertainty described below.

complex relatively late in Phase III (or perhaps even in Phase IV), just prior to or coinciding with the construction of the church.

A brief discussion of the Negev wheel-made lamps from the recently published Petra North Ridge excavations is also necessary here. While Barrett (2020: 364-365, 367-368) accepts a 5th-8th century date for the type, it is worth noting that of the nine examples found in phased contexts in the North Ridge excavations, eight were found in contexts assigned to Phase V.2 (7th century AD) or later, lending some support to the dating proposed above. One example, however, was found in a context, Locus 409, that Perry (2020: 33, 81) places in Phase I or II (Nabataean or Late Roman) based on Nabataean ceramics found in the locus. This would be a very early date for the type, but the dating of this context seems to have been difficult, and Barrett (2020: 367) instead assigns it to Phase VI (Late Islamic to Modern). Regardless of how this locus is interpreted, this discussion demonstrates that there is no secure evidence for the emergence of the Negev wheel-made lamp before the 6th century.

Conclusion

A review of the archaeological evidence for destructions caused by the 418/419 earthquake reveals that Russell's (1985: 39) suggestion that it was '[p]robably far more extensive than texts indicate' is incorrect. In fact, it seems that its effects were considerably smaller. In large part, overestimation of its effects is due to overreliance on coin frequencies without necessary consideration of the processes that may have led to certain periods being underrepresented in numismatic assemblages. For the 5th century, these are not limited to the 418/419 earthquake, but also include possible overproduction of coinage in the later 4th century, economic downturn across the entire Eastern Mediterranean, the continued economic effects of the 363 earthquake, and a 5th century drought, among other possible reasons (Fuks *et al*. 2017; Safrai 1998: 129-132;

2011-2014).

A critical review of the dating evidence from al-Zantur I Spätrömisch II indicates that this destruction has been misdated by at least a century. Spätrömisch II was occupied at least into the 6th century, and if an earthquake was responsible for its destruction, the Areopolis earthquake of ca. 597 is a more likely candidate. This returns the emergence of the Negev wheel-made lamp to the 6th century, in line with essentially every other site where it occurs. This revision also has implications for the dating of the Petra Church, which relied heavily on comparison to the material from al-Zantur, and other sites in Petra. Taken on its own, the evidence indicates that the Petra Church was built in the early 6th century, rather than the mid-5th.

As a final point, although archaeologists working in historical periods are often reluctant to rely on radiometric dates, expanded use of radiocarbon dating would provide a crucial additional source of evidence, as has been demonstrated over the last several decades in the Iron Age archaeology of the region (e.g. Levy and Higham 2005) and, for Late Antiquity, in the recent final report of the Petra North Ridge project (Perry 2020). I am not suggesting that Late Antique archaeology adopt the date-centric nitpicking of the Iron Age 'chronology debate,' but it is nonetheless the case, as demonstrated here, that there are chronological issues in Late Antiquity that radiocarbon dating would help resolve, which in turn have implications for our broader understanding of the period.

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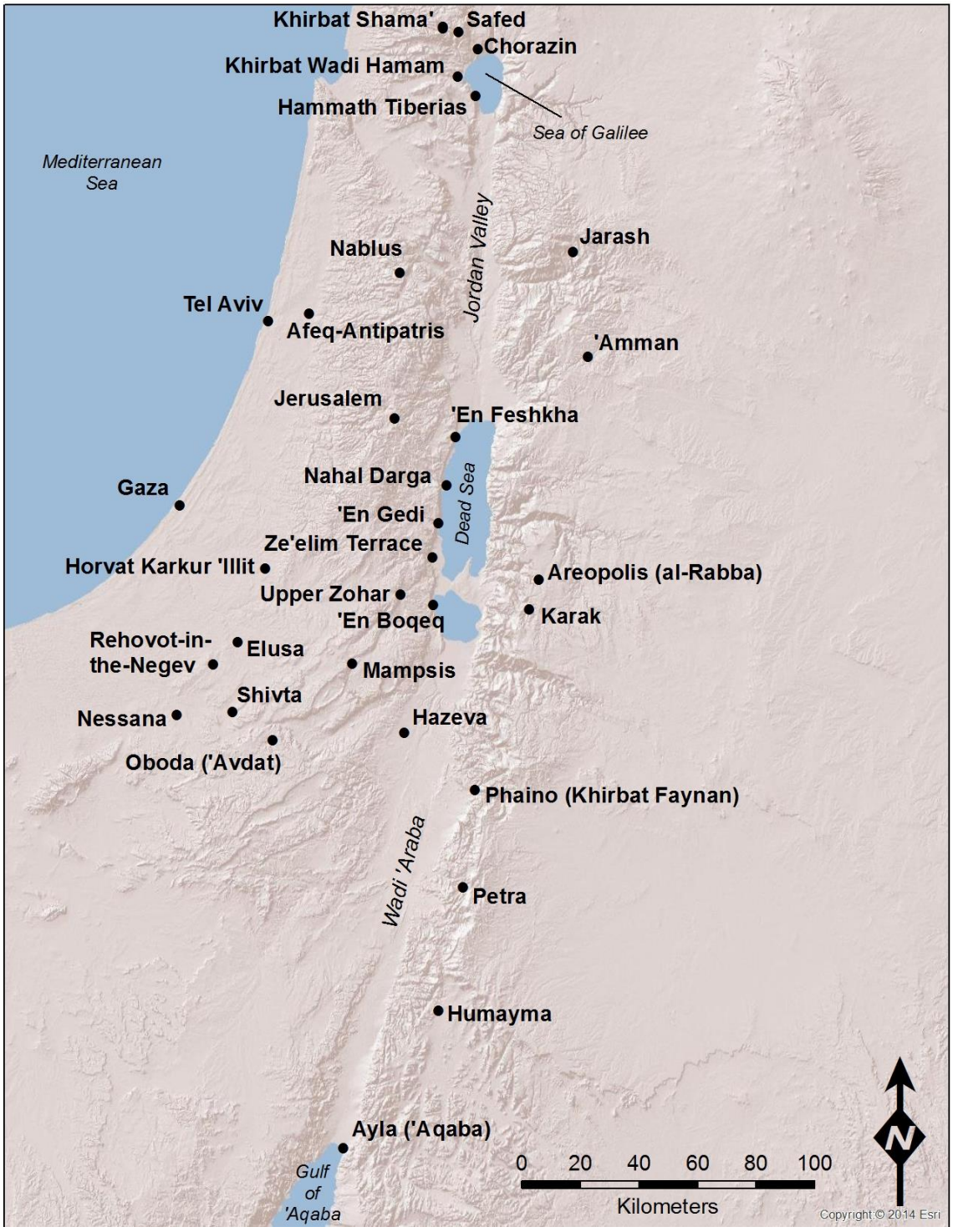
Figure Captions

Figure 1. Map of archaeological and geological sites referenced in the text (Basemap: © Esri).

Figure 2. Map of Petra with the locations of major excavations marked (Basemap: © Esri).

Figure 3. Two examples of Negev wheel-made lamps found during the University of Chicago and Department of Antiquities of Jordan excavations at ‘Aqaba, southern Jordan (Photo: courtesy of Donald S. Whitcomb).



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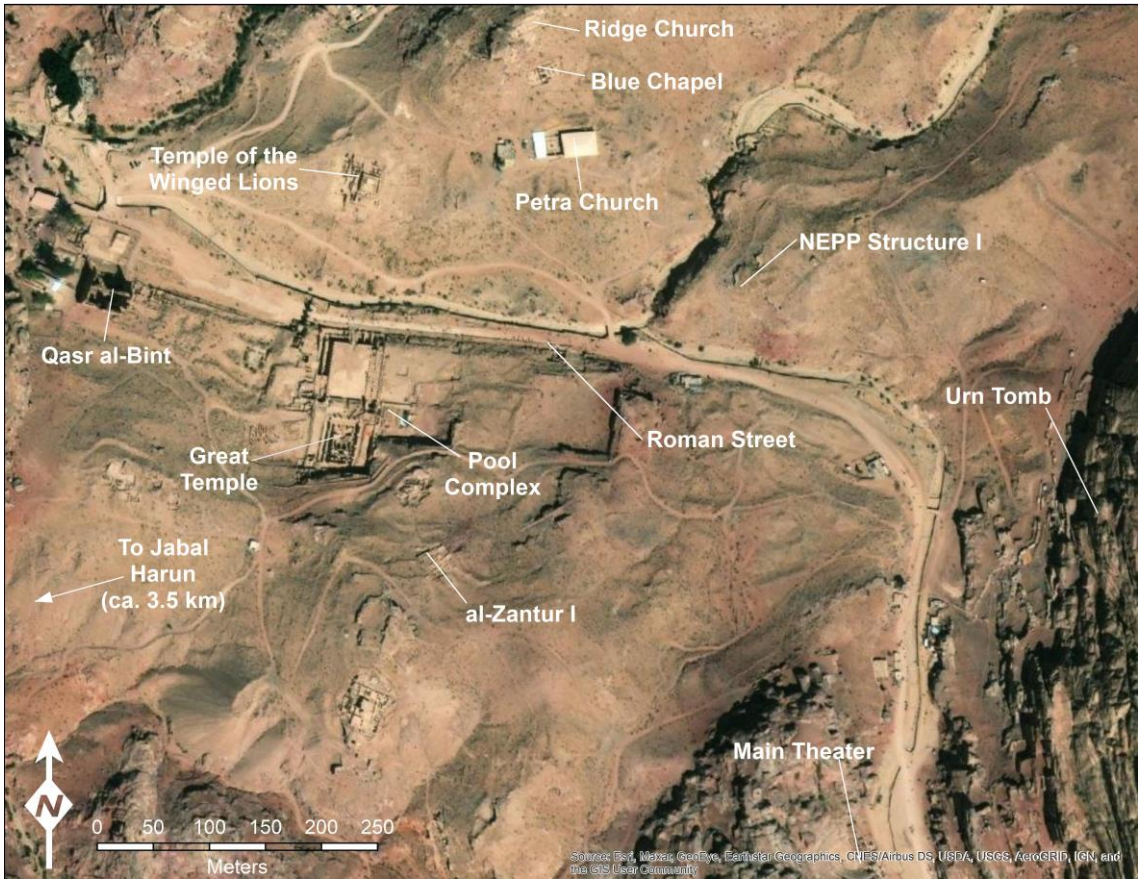

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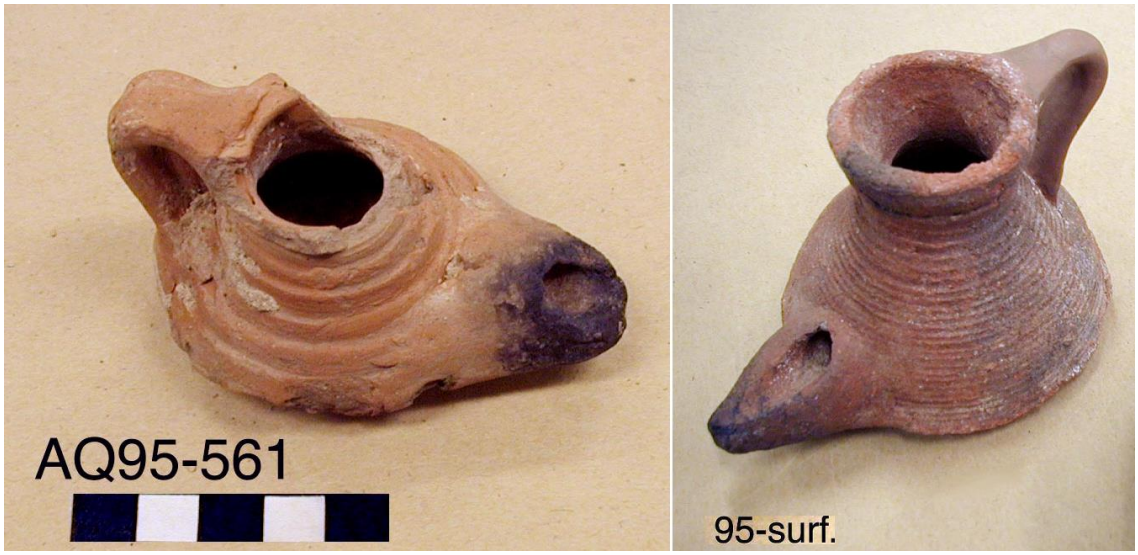

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Table 1: List of sites in and near Petra (other than al-Zantur) with destructions attributable to earthquakes in 363 AD and the 6th century

Site	363 destruction phase	Ca. 597 destruction phase; date proposed by excavator	Bibliography	Notes
Petra				
Great Temple	IX	XI; 551 AD	Joukowsky 2009: 294	
Jabal Harun	IV	VIII; mid-late 6th century AD	Fiema 2016	
Main Theater	No 363 destruction	VII; 746-748 AD or 551 AD	Hammond 1965: 65; 1996: 7	The Phase VII destruction of the Main Theater is difficult to date, as the structure had gone out of use long before. It may be the result of either the late 6th century earthquake or the mid-8th century earthquake.
North Ridge	Pre-Phase III	Pre-Phase V.1	Perry 2020: 58, 64	Neither event was identified on the North Ridge, but Perry (2020: 58) suggests that Phase III construction likely postdates the earthquake of 363. Likewise, the early 7th century Phase V.1 abandonment may have been caused by a late 6th century earthquake.
Petra Church	II/III	VIII?; late 6th-early 7th century AD	Fiema 2001b	Fiema (2001b) attributes the Phase II/III transition to the 363 earthquake. Although by no means certain, the Phase VIII destruction may be related to the late 6th century earthquake (see main text).
Pool Complex	IV	VII; 551 AD	Bedal 2003: 78-79, 82-83	

Qasr al-Bint	Not numbered	Not numbered; 6th century	Renel 2013; Zayadine 1985: 249	Renel (2013: 349) has proposed that the post-363 occupation at Qasr al-Bint was abandoned in the early 5th century, possibly as a result of a major flood (Paradise 2011). Nonetheless, it is possible that Qasr al-Bint was abandoned due to the 5th century flood but also damaged during the late 6th century earthquake. Fiema (1998: 420) dates the final destruction of the building to the "mid-fifth century AD or slightly later," but the area seems to have gone out of use fairly gradually, with 6th-7th century ceramics found in the westernmost room. It is possible, though by no means certain, that damage from the earthquake of 363, in combination with early 5th century flood damage (Paradise 2011), caused the building to collapse slowly over the next several centuries, ultimately ending with the late 6th century earthquake.
Roman Street, Shops	Not numbered	Not numbered; 5th century	Fiema 1998	
Temple of the Winged Lions	Not numbered	Not numbered; 551 AD	Hammond 1996: 7	Ward (2016: 144) has pointed out that the evidence for dating the major destruction to 363 is quite limited, although this is still the most reasonable date for this destruction, and Erickson-Gini and Tuttle (2017: 144-145) note the lack of 6th century material at both the Temple of the Winged Lions and the residential complex in nearby Area I, although this may simply indicate that the area was abandoned prior to its destruction in the late 6th century.
Outside of Petra				
'En Hazeva	Not numbered	Not numbered; early 6th century AD	Erickson-Gini and Bekes 2019	

Khirbat Faynan	Area 16, Terrace 3, local stratum 2a	Area 16, Terrace 2, not numbered	Unpublished, but see preliminary report in Levy et al. 2012: 430-435