Palestine Exploration Quarterly, 147, 3 (2015), 230–246

WHY IS THE MINARET SO SHORT? EVIDENCE FOR EARTHQUAKE DAMAGE ON MT ZION

Motti Zohar, Rehav Rubin and Amos Salamon

On top of King David's Sepulchre at Mt Zion there is an Ottoman minaret known as al-Nabi Da'ud. Compared with other minarets in Jerusalem, al-Nabi Da'ud seems to be somewhat shorter, and has a squat-like appearance. To track why it is shorter than other minarets, we inspected written historical sources, a sequence of old drawings dated between the mid-eighteenth and mid-nineteenth centuries and analysed the minaret's metric proportions. In drawings dated to and before 1833, the minaret is portrayed much higher than in drawings and photographs dated to and after 1838. Furthermore, comparative height-diameter ratio of various parts of the minaret does not fit those of its counterpart, the al-Qal'a minaret. Thus, we suggest that the minaret was originally built higher but damaged during the 1834 earthquake, and reconstructed to a lower height sometimes afterwards.

Keywords: 1834 earthquake, minaret, Jerusalem, Mt Zion, Ottoman buildings

1. INTRODUCTION

The complex recognised as King David's Sepulchre is an impressive structure located on Mt Zion, southwest of the Old City of Jerusalem (Fig. 1), and on top of that complex stands the cylindrical minaret of al-Nabi Da'ud. Because of the distinct location of the complex on the high summit of Mt Zion the minaret can be spotted from a far distance, even several kilometres away. It is reasonable to assume that this was the intention of the minaret's constructors; to build a monument that would be high enough above Jerusalem's landscape to serve as a prominent symbol of Islamic sovereignty.[1] However, the present height of the minaret hardly seems to suit this purpose. Instead of a tall erect shaft, the minaret has a squat-like appearance and is relatively short relative to other minarets in Jerusalem (Alud and Hillenbrand 2000, 659). This raises the question whether the al-Nabi Da'ud's minaret was originally built much higher, but might have been damaged sometimes later, renovated and shortened. Early photographs of Jerusalem dated after the mid-nineteenth century show the proportions of the minaret very much similar to those we see today (Fig. 2). That is, if the minaret had indeed been damaged or even collapsed, it must have occurred sometimes before the mid-nineteenth century, and a strong earthquake might be a plausible reason for that.

Indeed, two destructive earthquakes struck Palestine during the first half of the nineteenth century. The second event was the more destructive of the two and occurred on 1 January 1837. It caused damage mostly in regions in the Galilee and southern Lebanon but only limited damage in Jerusalem (Ambraseys 1997; Nemer and Meghraoui 2006). The first event in May 1834,[2] however, caused considerable concern and damage in central Palestine (Fig. 3). Jerusalem suffered badly: part of the wall near the al-Aqsa Mosque, the Church of the Ascension, the Church of the St Prodromos and the Church of the Holy Sepulchre were reported to have been damaged (Ambraseys 2009, 642 and references therein). Neophitus, the Greek monk from Mar-Saba, reported that during the 1834 earthquake: 'A minaret fell in Jerusalem, and another one on the Mount of Olives' (Spyridon 1938, 92). The latter minaret is probably

Address correspondence to: Motti Zohar, Geography, Hebrew University of Jerusalem, Jerusalem, Israel.
Email: motti.zohar@mail.huji.ac.il

 DOI: 10.1179/1743130114Y.0000000016

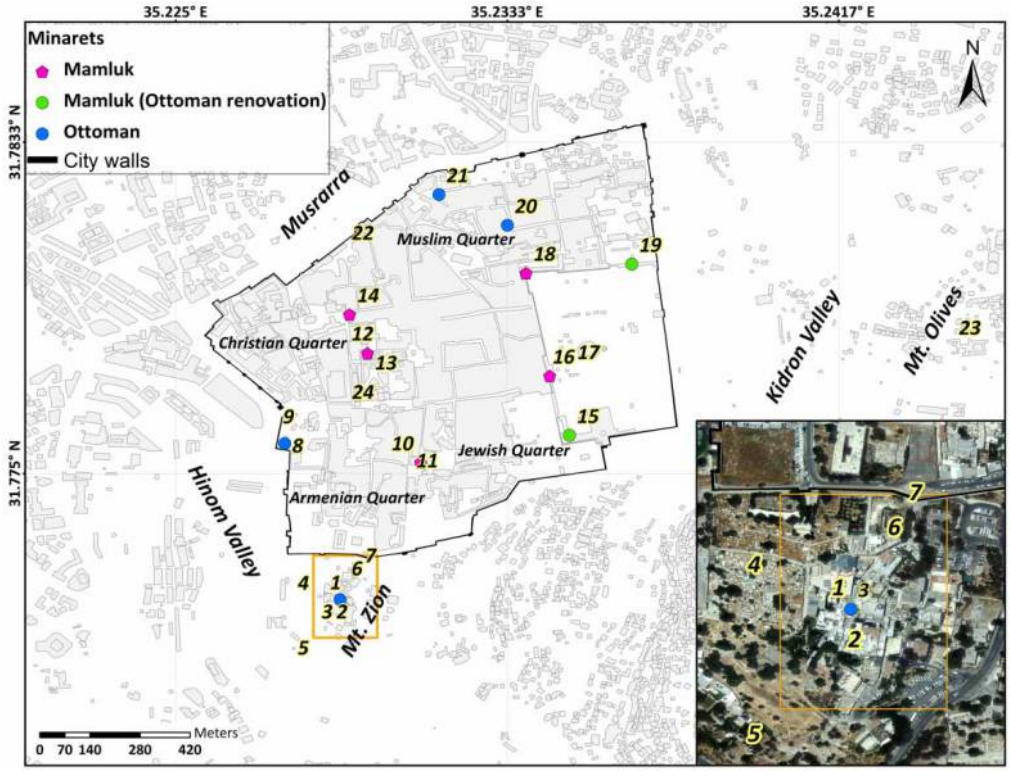

Fig. 1. The Old City of Jerusalem and the King David Sepulchre complex (outlined in orange and also in the inset). Major structures and minarets within the area include: (1) Dormition Church; (2) the King David Sepulchre complex; (3) al-Nabi Da'ud minaret; (4) Greek-Orthodox cemetery; (5) Protestant cemetery; (6) Armenian church of the House of Caifas; (7) Zion Gate; (8) David Citadel with the al-Qal'a minaret; (9) Jaffa Gate; (10) 'Hurva' synagogue (11) al-Omari minaret; (12) Church of the Holy Sepulchre; (13) al-Jami Omar mosque and minaret; (14) al-Hanaqah mosque and minaret; (15) al-Fakhriyya minaret; (16) Bab al-Silsila minaret; (17) al-Aqsa mosque; (18) al-Ghawanima minaret; (19) Bab al-Asbat minaret; (20) al-Hamra mosque and minaret; (21) al-Maulawiyya mosque and minaret; (22) Damascus Gate; (23) Church of the Ascension; (24) Church of the St Prodromos. Note the classification of minarets into three types: Mamluk, Ottoman, and Mamluk minarets that were probably renovated by the Ottomans (for further discussion see Alud and Hillenbrand 2000, 334).

the one located at the site of the Ascension complex on the Mount of Olives, and we suggest here that the former is the minaret of 'al-Nabi Da'ud.[3] This claim is analysed and discussed thoroughly in this paper using old drawings, photographs, textual sources and is complemented by field surveys.

2. DAVID SEPULCHRE AND THE AL-NABI DA'UD MINARET

The complex of King David Sepulchre is located only a few minutes' walk south of the Zion Gate. On the west it is surrounded by the massive Dormition Abbey and Greek-Orthodox cemetery. A second cemetery, of the Protestants, surrounds the complex on the south. North of it, close to the Zion Gate, the Armenian Church of the House of Caiphas is

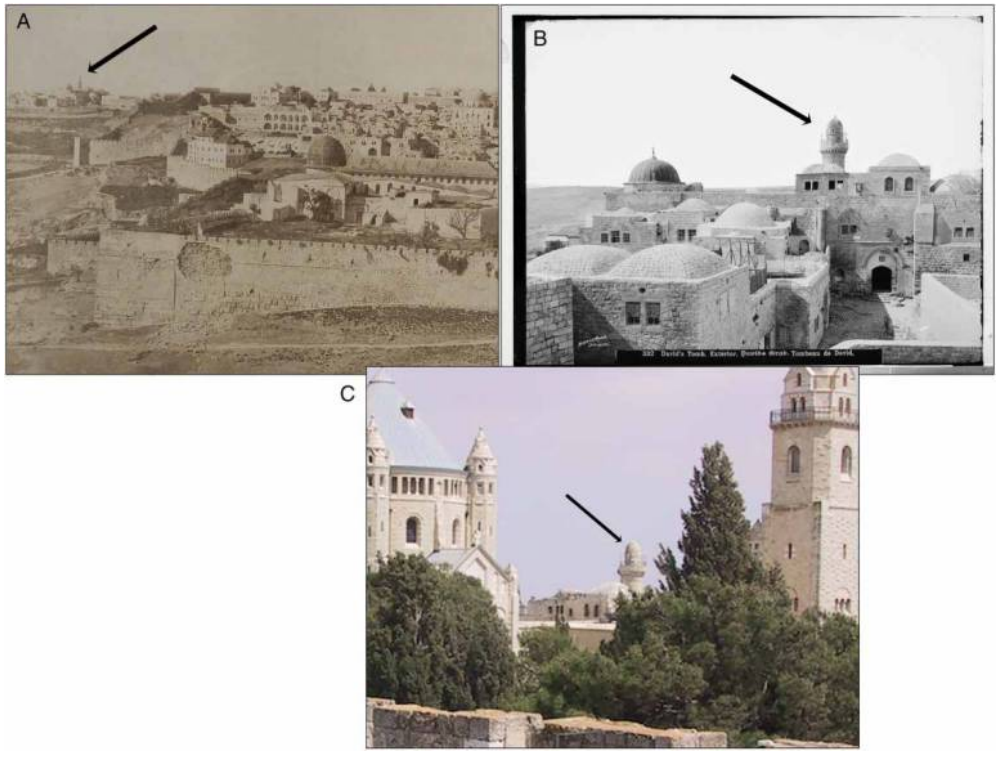

Fig. 2. Photographs showing the height of the al-Nabi Da'ud minaret in various periods after mid-nineteenth century: (A) *c.* 1870 – Mt Zion in a photograph of Jerusalem from the east, probably taken from the Mt of Olives (Source: Bonfils 1877). Note the low shaft of al-Nabi Da'ud is very similar to its height today; (B) between 1898 and 1914 (source: American Colony Photograph Department 1898–1914. Jerusalem (El-Kouds). David's tomb, exterior, Library of Congress Prints and Photographs Division Washington, DC 20540 USA: G. Eric and Edith Matson Photograph Collection, Prints & Photographs Division, LC-DIG-matpc-06557), presenting the northern façade of the complex; and (C) April 2012, taken from the southern promenade of the Old City's walls. Apparently no dramatic changes were made in the minaret's structure after mid-nineteenth century (photograph C: M.Z.).

located (Fig. 1). The complex has two stories, three entrances (north, south, and east), halls, a garden, and courtyards. In its lower level is the traditional 'Tomb of David' and above it is the Crusaders' 'Hall of the Last Supper', namely the Coenaculum. The complex also contains three mosques and a zawiya (Alud and Hillenbrand 2000, 659–64; Vincent and Abel 1922, 422–40). Recent archaeological excavation indicates activity in the complex during the Byzantine, Crusader, Mamluk, and Ottoman periods (Re'em 2012). The complex was repeatedly destroyed and reconstructed several times in the past, mostly because of changing governorships (Cohen 1982; Jacoby 1986; Praver 1947–48).

The al-Nabi Da'ud minaret is built on top of the mosque at the northern section of the complex, a few meters west of the Coenaculum's ribbed dome (Fig. 4). It is built of masonry stones forming a cylindrical shape borne by a massive plinth. The plinth, decorated by four convex curves at its upper corners, includes also a short eastern entrance that leads to a single spiral staircase leading up to the gallery. Two moulding rings decorate the shaft of

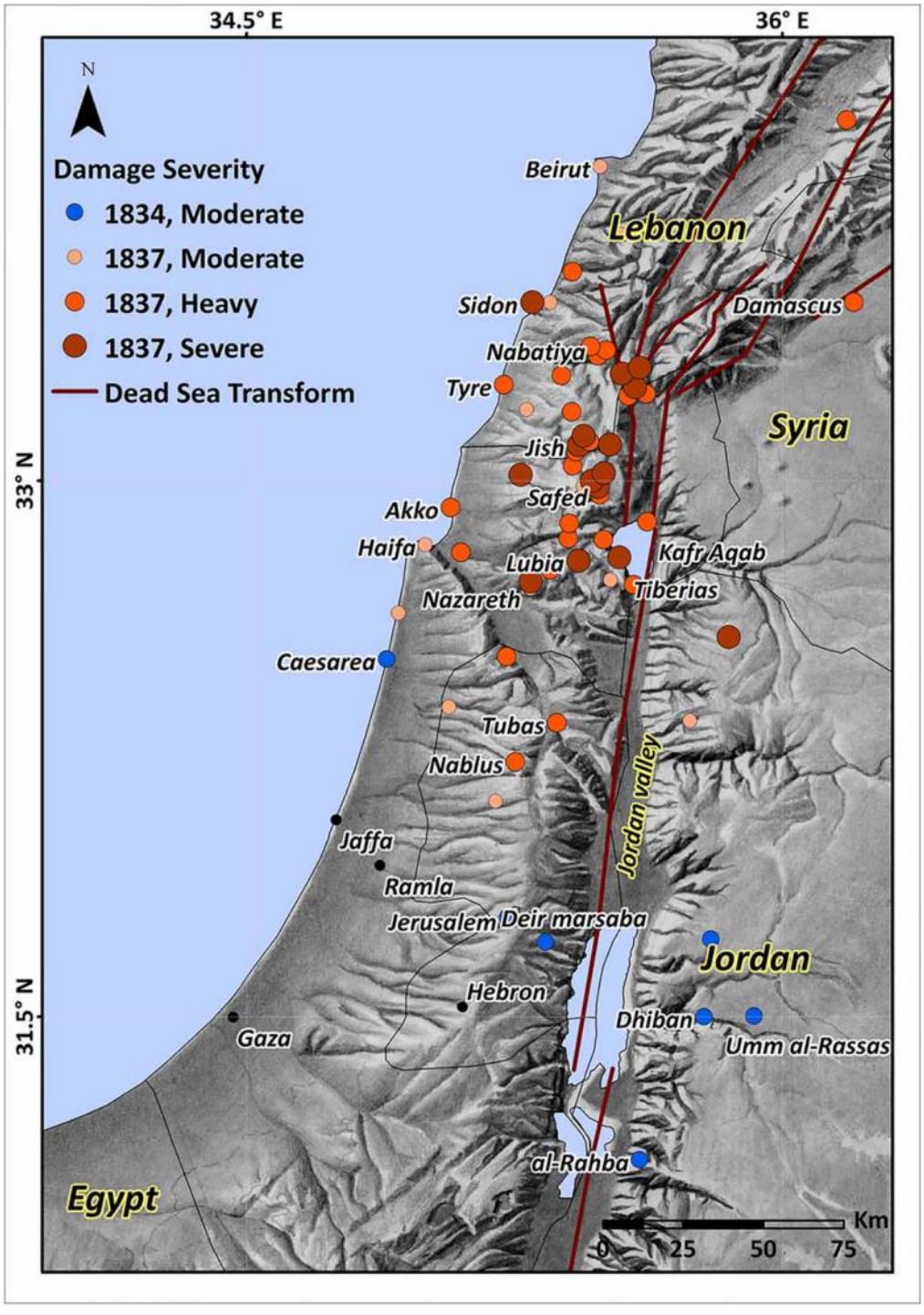

Fig. 3. Damage distribution and its severity, ranging between 'Moderate' and 'Severe' (adapted from Zohar *et al.* 2013), of the May 1834 and January 1837 earthquakes, according to historical reports. Note that the damage that resulted from the 1837 event is more severe in northern than in central Palestine and did not spread south of the Nablus region.

Fig. 4. Views of King David's sepulchre and visible damage (noted by red arrows): (A) the shaft of the minaret; (B) Damaged wall beside the eastern entrance facing the Muslim cemetery; (C) inner spiral stairs of the minaret. Note the damage to the inner stones; (D) Supporting iron anchors on the southeast corner of the complex (black arrows); (E) Ribbed dome on the roof above the Coenaculum (photographs: M.Z.).

the minaret: the first appears at the base close to the plinth while the second is below the corbelled gallery base. Cracks and signs of possible reconstructions appear over the shaft between the two moulding rings and also inside the minaret, on the walls of the inner staircase. Situated on top of a wide base is a single-stage gallery surrounded by a metal barrier (Fig. 5). The minaret is completed by an ashlar cone 8.2 m high whose perimeter close to the plinth is 7.2 m (Table 1).

The part of the complex where the Coenaculum's dome and the minaret are located seems to have been seriously damaged in the past. Prominent reconstruction is detected at the eastern wall that faces the Muslim cemetery (Fig. 4). Noticeable are two sections of repairs demarked by cracks and delineated by a non-uniform serrated border that distinguishes between large (about 50 × 60 cm) and small (about 30 × 30 cm) limestone building blocks. Most likely the wall was originally built using the larger stones and only after, when it was severely damaged, renovation was carried out and smaller building blocks replaced the larger ones. A few decades ago this wall and other parts of the complex were reinforced by a series of iron anchors which were inserted into the inner sides of the walls and additional retrofitting was made to prevent their further deterioration (Modena *et al.* 2010).[4]

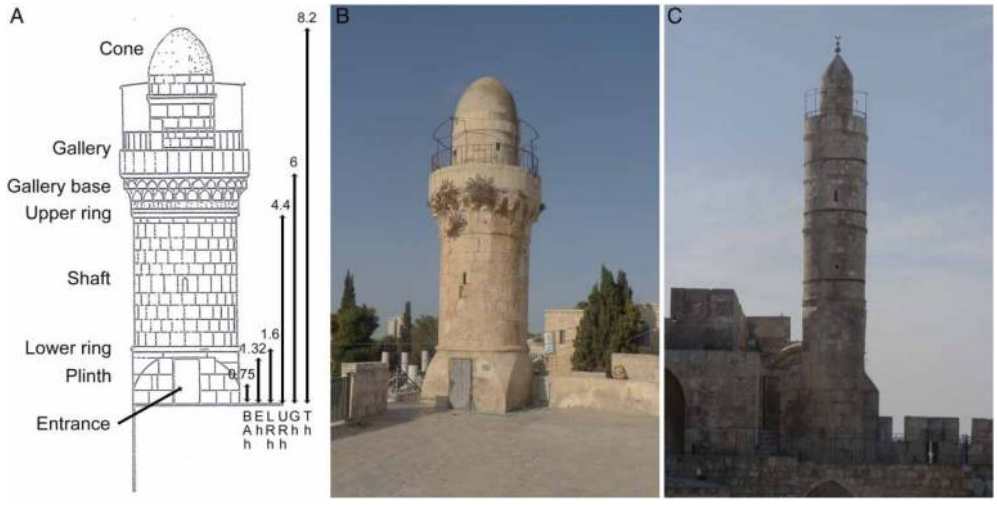

Fig. 5. (A) Structure and main parts of the al-Nabi Da'ud minaret (adapted from Alud and Hillenbrand 2000, 659). Vertical denoted arrows represent height measurements of the various parts: Eh – entrance; Bah – base-arc; LRh – lower molding ring; URh – upper molding ring; Gh – Gallery; Th – total . See also Table 1; (B) Eastern view of the minaret; (C) Northern view of al-Qal'a minaret (no. 8 in Fig. 1); Plinth of al-Nabi Da'ud (D) and al-Qal'a (E) minarets. Note the similarity between the two bases (photographs B and C: M.Z.).

3. THE MINARET IN HISTORICAL SOURCES

Sacred for Jews, Christians, and Muslims, Mt Zion was visited by many pilgrims and western travellers (Röhricht 1890; Ish-Shalom 1965). Its first association with religious traditions was probably made by the Jewish traveller Benjamin of Tudela (*c.* 1165–73) in the twelfth century claiming that the complex hosts the graves of several Jewish kings (Asher 1927).[5] In the thirteenth century, after the Mamluks conquered Jerusalem, religious disputes concerning the ownership of the complex emerged (Praver 1947–48) and lasted, although not continuously, for nearly 300 years. Fabri reported that towards the end of their rule over Palestine, the Mamluks decided to ruin the existing Christian Church and convert the lower vault of

TABLE 1: The height (in metres) of the elements in the al-Nabi Da'ud and the al-Qal'a minarets. Parts taller than 2 m were estimated according to the width of a single cut-stone block times the number of the building rows

Minaret	BAh	Eh	LRh	URh	Gh	Th	D	P	NB	TH/D ratio
al-Nabi Da'ud (C.1524 CE)	0.75	1.32	1.6	4.4	6.0	8.2	2.35	7.2	2	3.489
al-Qal'a (C.1531 CE)	1.0	1.5	2.5	9.25	10.0	12.75	2.95	9.26	4	4.322
Dimension ratio	0.75	0.88	0.64	0.47	0.6	0.64	0.79	0.77		

Measurements include: Bah – base to arc height; Eh – entrance height; LRh – lower molding ring height; URh – upper molding ring height; Gh – Gallery height; Th – total height; D – diameter close to the plinth; P – perimeter close to the plinth; NB – number of molding rings (see Fig. 5A for a visual representation of the various elements). The dimension ratio represents the ratio between similar parts of the two minarets whereas the rightmost TH/D column represents the ratio between the total height and the diameter of each of the minarets in their current status.

the complex into a mosque (Fabri 1480–83, 301–305). The Ottomans, who defeated the Mamluks in 1517 and took over Palestine, continued the Islamic construction in the complex and in 1524 converted also the upper hall into a second mosque. The exact construction date of the al-Nabi Da'ud minaret, however, is not explicitly mentioned in the sources but by virtue of its design it looks typical of Ottoman architecture (Alud and Hillenbrand 2000, 659).

In order to prevent Christians from visiting the complex, in the sixteenth century the Ottoman sultan put the care and treatment of the whole complex in the hands of the Dajani family, one of the families in Jerusalem closely associated to him (Layish 1985). They took over complete responsibility of the complex but did not reside within it; they used an external building close to the southern wall of the Old City for their needs (Ben-Arieh 1979). Under their surveillance, only Muslims were allowed to enter. The western travellers Richard Pocoke in 1738 and Frederick Hasselquist in 1751 described the sepulchre as including a mosque and also a minaret (Hasselquist 1766, 123; Pococke 1745, 9). Turner, who visited Jerusalem in 1815, briefly described the complex, but probably from the outside without entering it (Turner 1820, 194) while Bartlett managed to sneak into it in order to visit the sepulchre (Bartlett 1844). None of these or other reports mentions damage to the minaret or repairs that were carried out between 1800 and 1850. An interesting description is provided by Seetzen, who visited the site in 1806. He noted that despite being partly ruined, the mosque of al-Nabi Da'ud is the most prominent mosque outside the walls of Jerusalem (Seetzen 1854–59). This report is unique, being the only written source from the middle of the nineteenth century implying that perhaps the prominence of the mosque was because of high minaret.

4. THE MINARET IN OLD DRAWINGS

4.1. Drawings dated to and before 1833

Mt Zion was also the focus of many artists (Ben-Arieh 1977; Ben-Arieh 1986, 1997, 2001, Vilnay 1965). Most of the drawings dated prior to the seventeenth century are somewhat stylised and thus their utilisation for obtaining the realistic dimensions of depicted features is hard. In the seventeenth century, however, drawings of Jerusalem gradually appear to be more reliable and roughly reflect the contemporaneous landscape of Jerusalem (e.g., the drawings of Quaresmius 1639; Bruyn 1698; Tirion 1732). Towards the end of the eighteenth century, detailed tangible drawings were published. Fig. 6 presents mid-eighteenth and several early nineteenth century drawings of Jerusalem. All are drawn from the east, probably some point on the Mt of Olives ridge. The earliest drawing, dated to mid-eighteenth century, is by Carsten Niebuhr. It is an abstracted drawing and lacks a few important features (Niebuhr 1837).[6] Yet, Niebuhr drew the al-Nabi Da'ud as an erect minaret, high above its surroundings. The following drawings, dated to the beginning of the nineteenth century, are more reliable in their proportions. The drawing of Luigi Mayer from 1803 presents a tall minaret with a high gallery above its base (Mayer 1804). This is also the case of the drawing of Auguste Forbin from 1817 to 1818 (Forbin 1819).[7] The last drawing in Fig. 6 is by Frederik Henniker dated to 1822. It is much more detailed than the former noted drawings and presents an accurate image of the complex as well as the minaret (Henniker 1823). In the drawing, one can also detect an external building, probably the one used to host the Dejani family. Notable is the resemblance of heights between the al-Nabi Da'ud and al-Qal'a (the Citadel, David's Tower) minarets in three of the four drawings (Fig. 6). When we measure the heights of both minarets as the artist sketched them, the ratio between the two minarets is 0.99, 0.97, and 1.03 in the drawings of Niebuhr, de Forbin, and Henniker, respectively (Table 2). That is, the artists at the beginning of the nineteenth century have attributed almost a similar height to both the minarets.

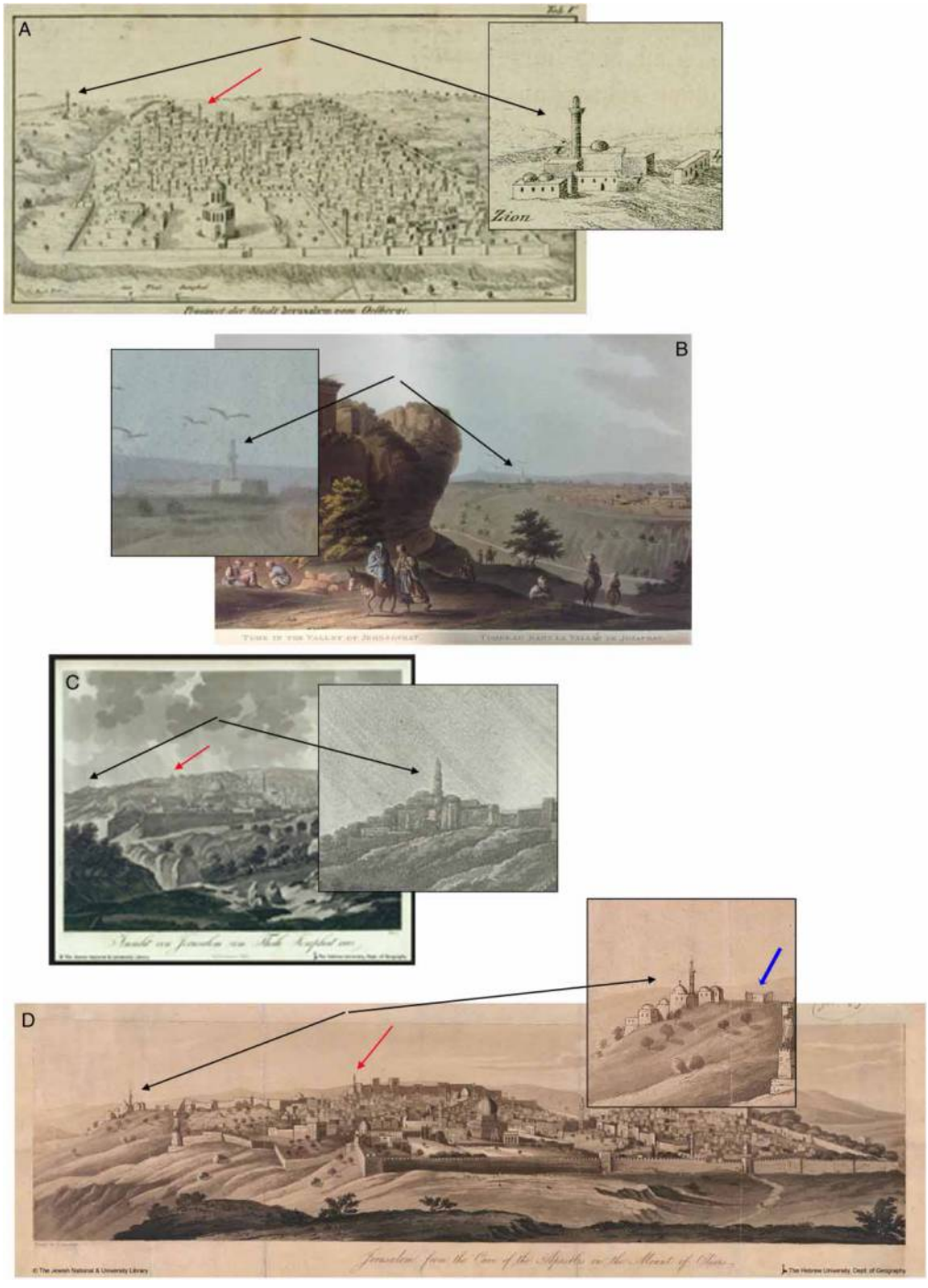

Fig. 6. Pre-1834 Drawings and maps of Jerusalem. Note the high shaft of al-Nabi Da'ud minaret (magnified and also marked in black arrows) in three of the drawings, and its similarity to the al-Qal'a minaret (red arrows): (A) Carsten Niebuhr, 1776 (Niebuhr 1837); (B) Luigi Mayer, 1803 (Mayer 1804); (C) Auguste Forbin, 1817–18 (Forbin 1827); (D) Frederik Henniker, 1822 (Henniker 1823). The blue arrow denotes an external structure that probably hosted the Dejani family.

Two interesting and highly detailed drawings of Mt Zion were sketched after a visit to Palestine by Frederick Catherwood and Francis Arudale in 1833 (Fig. 7).[8] The Arundale drawing is sketched from the south of Mt Zion and includes both the minarets of al-Nabi Da'ud and al-Qal'a (Arundale 1837). The gallery of al-Nabi Da'ud is drawn much taller than it appears today and the height of the two minarets seems to be equal (Fig. 7; Table 2). The second drawing is not by Catherwood but rather by the British artist George Balmar (Balmar 1835). As far as we know, Balmar never visited Palestine but used a sketch Catherwood had made during his visit (Ben-Arieh 1970, 110; 1997).[9] The drawing seems to be precise and accurate; most of the proportions of the main features are very much similar to those we observe in the photographs of the late nineteenth century and today (Figs. 2 and 4). However, the shaft of the minaret as drawn by Balmar is much higher than it is today (Fig. 7); its total height is roughly four times the height of the ribbed Coenaculum dome whereas today it is only about 2.5 times.

4.2. Drawings dated to and after 1838

Arundale and Balmar are the last artists to draw Mt Zion in its pre-1834 condition. After that, there is a period of nearly 5 years without visual evidence on the height of the al-Nabi Da'ud minaret. The earliest drawing afterwards is that of William Henry Bartlett from 1838 according to a sketch made by Thomas Allom (Fig. 8).[10] Bartlett drew an isolated complex on Mt Zion with a very short minaret, almost as high as the Coenaculum dome (Bartlett 1838). A year later the recognised artist David Roberts also visited Jerusalem and like many preceding artists, he drew the Old City from the east (Roberts 1842–49).[11] The drawing seems to be quite accurate and includes many of Jerusalem's features. Compared with Bartlett, the minaret that Roberts sketched is even shorter and appears to be ruined: a square cube is shown at the place where the minaret is supposed to be drawn. Later, in 1853, Bartlett makes his second visit to Jerusalem but this time drew King David's Sepulchre from close range (Bartlett 1855, 66). The details of the complex look realistic and proportional whereas the minaret is drawn squat with a short gallery. A decade afterwards, only a few years before the first photographs of Mt Zion were made, the Italian Ermete Pierotti also sketched the complex (Pierotti 1864).[12] His sketch corresponds accurately to the current dimensions of the complex and the minaret is depicted very similarly to the structure we see today.

5. COMPARISON WITH OTHER MINARETS IN JERUSALEM

In general, historical minarets are tall slender structures made of cut-stone blocks and can be either a separate or an integral part of a mosque's structure. Studies of present and historical earthquakes in Turkey demonstrate that the structure of the minaret is vulnerable to strong seismic motion (Motosaka and Somer 2002; Sezen *et al.* 2008). Dogangum *et al.* (2008) conclude that the structural behaviour of the minaret is dependent on its height and the spectral characteristics of the seismic motion. Turkish minarets range in height between 15 and 70 m (Oliveira *et al.* 2012) and are prone to be damaged mainly in their lower parts, close to the transition between the base (plinth) and the minaret's shaft (Sezen *et al.* 2008; Sezen and Dogangum 2012). Although the Turkish minarets seem to be taller, Mamluk and Ottoman minarets in Palestine were also severely damaged during past earthquakes. For instance, the minaret attached to the al-Zidani mosque in Tiberias collapsed during the 1837 earthquake (Ambraseys 1997). Another example is the breakage at the upper part of the minaret at the Church of the Ascension in Jerusalem during the 1927 earthquake (Avni 1999, 42 in the appendix).

Dating of the destruction and construction of minarets in Palestine is made based on shape and form. In general, Mamluk minarets are square whereas Ottoman minarets have

TABLE 2: Artists that have depicted the minaret of al-Nabi Da'ud

Artist	Date of drawing	Measured units of height		Ratio	Notes
		al-Nabi Da'ud	al-Qal'a		
Carsten Niebuhr (1733–1815)	1776	13.3	13.4	0.99	Published in 1837 but in fact was drawn much earlier in 1776
Luigi Mayer (1755–1803)	1803	–	–	–	The al-Qal'a minaret is not depicted in this drawing and thus comparison between the two minarets is not possible
Louis Nicolas Philippe Auguste de Forbin (1771–1841)	1817–1818	12.03	13.4	0.97	
Frederick Henniker (1793–1825)	1822	19.5	18.9	1.03	
Francis Arundale (1807–53)	1833	13	11	1.18	Was portrayed from the south and thus, due to the perspective, the al-Nabi Da'ud minaret appears closer and higher than that of al-Qal'a
George Balmar (1806–46)	1833	–	–	–	Following a sketch of Frederick Catherwood (1799–1855). The al-Qal'a minaret is not depicted in the drawing
William Henry Bartlett (1809–54)	1838	11.3	19.2	0.58	Following a sketch of Thomas Allom (1804–1872)
David Roberts (1796–1864)	1839	8.6	29.3	0.29	The al-Nabi Da'ud minaret seems ruined
William Henry Bartlett	1853	–	–	–	The al-Qal'a minaret is not depicted in this drawing
Ermete Pierotti (*c.* mid-nineteenth century)	1864	–	–	–	The al-Qal'a minaret is not depicted in this drawing

The red line marks the transition in time between the tall and the short form of the minaret. The height of the minaret is measured in the various drawings as it appears in the digital screening, but the dimensionless ratio between the various elements of the al-Nabi Da'ud and the al-Qal'a minarets is what matters. Note the sharp change in that ratio after 1833, especially the low ratio in Roberts' drawing, which may represent the shape of the minaret before reconstruction.

a cylindrical shape (Bloom 1989). Hence, the al-Nabi Da'ud minaret seems almost certainly to be an Ottoman construction, probably built during the early sixteenth century (Alud and Hillenbrand 2000, 334). This was not the sole contribution of the Ottomans; in the Old City of Jerusalem they built three additional minarets (al-Mawlawiyya, al-Qal'a and al-Hamra) and renovated two other Mamluk minarets (al-Faqriyya and the Bab al-Asbat minaret). Although varying in shape and size, all five are built much higher than the al-Nabi Da'ud of today (Alud and Hillenbrand 2000, 659). Roughly, Ottoman and Mamluk minarets can be classified by

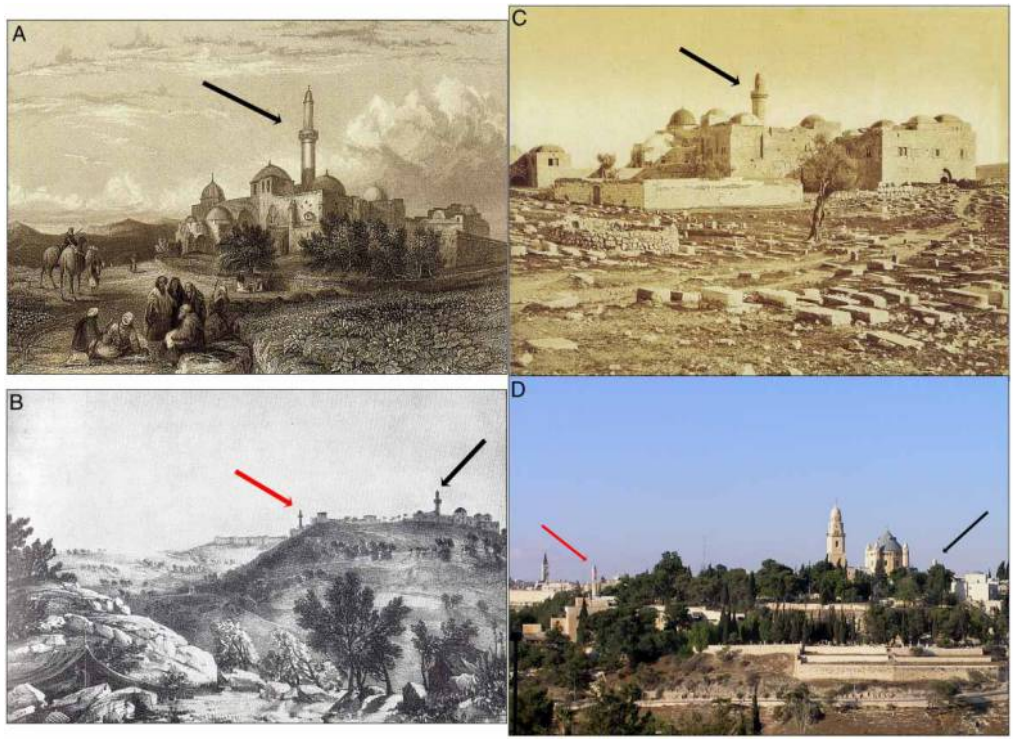

Fig. 7. al-Nabi Da'ud minaret in drawings from 1833 and similar views for comparison from mid-nineteenth century and 2013: (A) the complex of the David Sepulchre, by George Balmar after a sketch made by Frederick Catherwood in 1833 (Balmar 1835). The minaret appears high above the chapels, much more than it is today; (B) Mt Zion in 1833, by Francis Arundale (Arundale 1837). The height of the al-Nabi Da'ud minaret (black arrow) seems similar to that of the al-Qal'a minaret (red arrow); (C) a photograph taken by Felix Bonfils in *c.* 1870 (Bonfils 1877), approximately at the same spot where Catherwood had made his sketch. This time the minaret is much lower than that sketched by Balmar in section A. Unfortunately, a photograph from a similar spot and angle cannot be taken today due to the establishment of the massive Dormition Church (Fig. 1); (D) Current photograph of Mt Zion taken from the south (photograph: M.Z.). Note the low shaft of al-Nabi Da'ud minaret (black arrow) compared with the al-Qal'a's minaret (red arrow).

their function: (1) minarets located within a mostly populated area whose height was probably designated to enable the muezzin's call to prayer to be clearly heard in the mosque's surroundings; and (2) minarets aimed to serve as an Islamic symbol of sovereignty. The first class includes the Ottoman minarets of al-Maulawiyya (built 1586–87) and al-Hamra' (built *c.* 1530), the renovated minarets of al-Faqriyya and Bab al-Asbat, and the Mamluk minarets surrounding the Haram (Burgoyne 1990, 89). On the other hand, the Ottoman minarets of al-Nabi Da'ud and al-Qal'a (Fig. 5) along with the Mamluk al-Omari minaret seem to be related to the latter class (Alud and Hillenbrand 2000, 334).

Being located less than 500 m away from each other and built at the beginning of the sixteenth century by the Ottomans, both the al-Nabi Da'ud and al-Qal'a minarets share similar structure, decoration, and function. Table 1 presents the dimensions of several of the major elements of the two minarets. Accordingly, the al-Qal'a is taller and wider than its

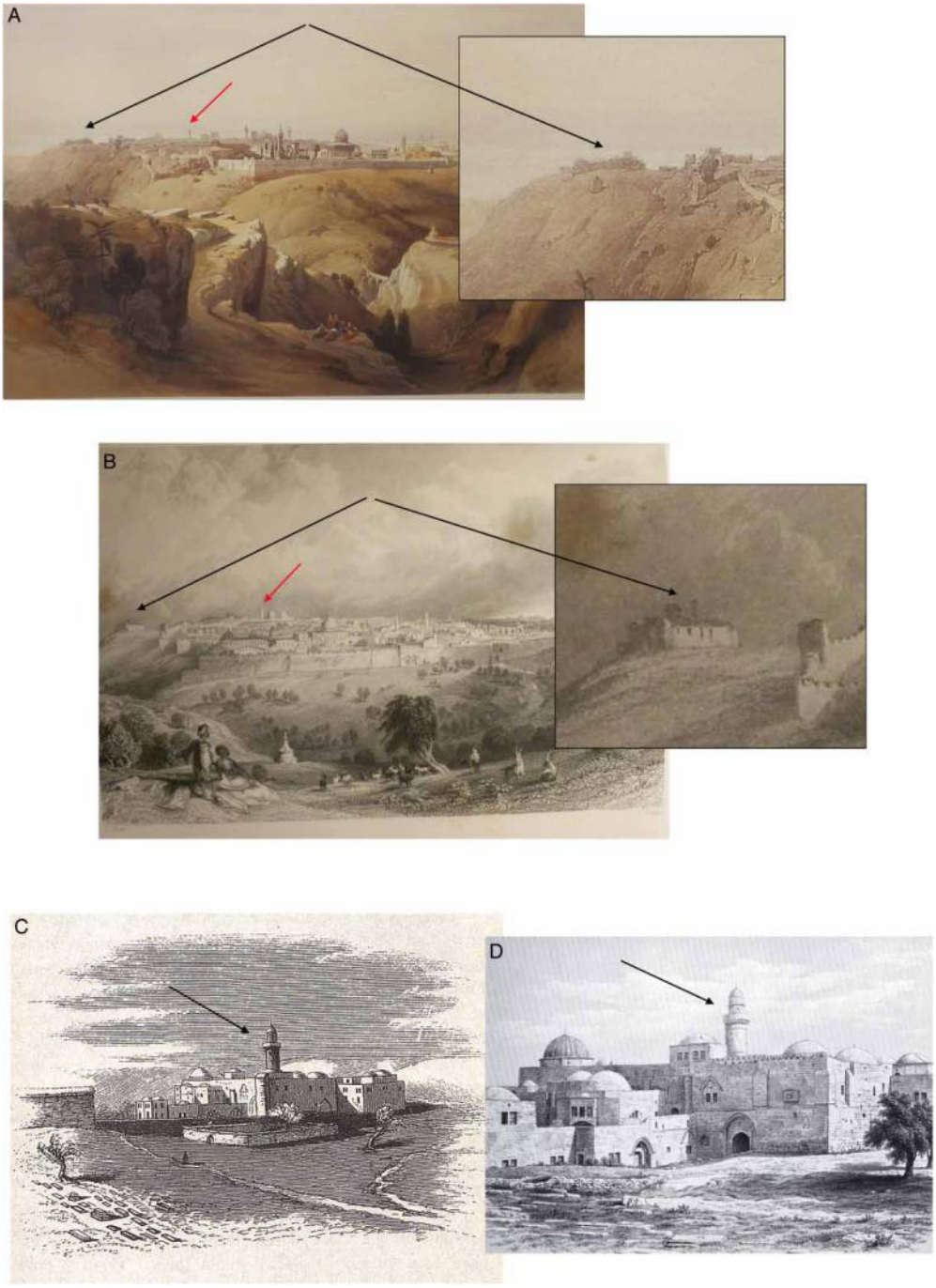

Fig. 8. The complex in drawings painted in and after 1838: (A) David Roberts, 1838 (Roberts 1842–49). The al-Nabi Da'ud minaret seems to be ruined; (B) William Henry Bartlett, 1842 (Bartlett 1844). Note the very low shaft in comparison with the al-Qal'a minaret; (C) Bartlett, 1853, during his second visit to Palestine (Bartlett 1855); (D) Pierotti, 1861 (Pierotti 1864). In the drawings of Roberts and Bartlett (images A and B), black and red arrows denote the al-Nabi Da'ud and al-Qal'a minarets, respectively.

counterpart. When comparing their perimeters close to the plinth, the resulting ratio is 0.79 and 0.77, respectively. Similar or higher ratios are achieved also when comparing adjacent heights of parts that are located below the top of the plinth. However, when comparing the height of the parts that are situated today above the plinth, the ratio decreases significantly and ranges only between 0.47 and 0.64. Furthermore, the ratio of the total height to diameter of al-Qal'a is 4.32 while that of al-Nabi Da'ud is only 3.48. Assuming that the construction of both the minarets was subjected to similar Ottoman architectural design and was implemented under Ottoman supervision, the height of al-Nabi Da'ud nowadays seems to be somewhat shorter,[13] also in comparison to Ottoman minarets elsewhere in the old city.

6. DID AN EARTHQUAKE DAMAGE THE MINARET?

In the absence of written sources, we used a sequence of old drawings to trace what might have occurred to the al-Nabi Da'ud minaret. This technique is not new and is widely used in research on historical geography (e.g., Rose 2000, 2001, Rubin 2006) and also for tracking past earthquake damage (e.g., Ambraseys and Karcz 1992; Hinzen 2013; Karniel and Enzel 2006; Zohar *et al.* 2014). The inspected sequence of drawings from the mid-eighteenth to the mid-nineteenth centuries reveals that the al-Nabi Da'ud minaret is sketched much taller in drawings dated up to 1833 than in those dated after 1833 (Table 2). Obviously, this is a qualitative approach that merely reflects the artist's realisation of the landscape as well as our interpretation nearly 200 years after. Yet, even though one of the drawings might be inaccurate, the cumulative impression cannot be ignored. Furthermore, drawings and panoramic views of the nineteenth century were considered an important tool for portraying the landscape (Ben-Arieh 1997, 40–56), and many were sketched by skilled artists and architects. Consequently, they provide a proportional and precise picture of the contemporaneous landscape. This is the case of the two drawings by Francis Arundale and George Balmar, depicting Mt Zion in 1833. Arundale was an architectural draftsman and Balmar based his picture upon the sketch of Frederik Catherwood, a British artist and architect (Ben-Arieh 1974, 1997, 46). Catherwood, is also one of the first artists to use the 'Camera Lucida' tool for projecting urban outlines over a canvas for drawing scenery sketches. During his journey he mapped the entire city of Jerusalem and sketched many localities using this tool (Ben-Arieh 1973). It is reasonable to assume that he also used the same technique for accurately sketching the David Sepulchre complex (Nir 1985, 67).

The first two drawings after 1833 are by Bartlett and Roberts from 1838 and 1839, respectively, and initiate a sequence of drawings that depict the minaret as short and squat. Both artists were considered very skilled and highly praised by their counterparts. Furthermore, Bartlett's work was even considered in his time as scientific material (Ben-Arieh 1997, 72). Roberts was not an architect but in general his drawings attempt to track reality. His sketch from 1838 of the al-Nabi Da'ud's minaret is exceptional; it is the only drawing in which the minaret appears to be ruined. Roberts, probably standing on the Mt of Olives, drew all the other minarets in the Old City as tall edifices. Surely he must also have detected the contemporaneous condition of the al-Nabi Da'ud minaret. The fact that he chose to portray a ruined minaret indicates that it had indeed collapsed or at least was in bad condition.

What emerges from the graphic evidence of time series of the drawings is that the al-Nabi Da'ud minaret was damaged sometimes between 1833 and 1838. The height-diameter ratio of its various parts as well as the comparison with those of al-Qal'a (Table 1) attests to this conclusion. If we take the logic of ratio further, we can suggest that theoretically the original height of the minaret of Nabi Da'ud had to be about 0.75–0.8 that of the al Qal'a minaret, i.e., about 9.5–10.2 m. This results in a height-diameter ratio (THD in Table 1) between 4.25 and 4.68, which matches the ratio of the al-Qal'a minaret. Unfortunately, we cannot determine at

this point where and how severe the damage was. Seismic motion models conducted in Turkey (Sezen *et al.* 2008; Sezen and Dogangum 2012) after the Izmir earthquake suggest that damage concentrates at the lower parts of the minaret.

Between the years 1833 and 1838, the time frame suggested here for the damage and repair of the al-Nabi-Da'ud minaret, two destructive earthquakes hit the Holy Land, in 1834 and 1837. Both of the events affected localities across Palestine but the possibility that the al-Nabi Da'ud minaret was brought down by the 1837 event can be ruled out. Inspection of the spatial damage that resulted from the 1837 earthquake (Ambraseys 1997; Zohar *et al.* 2013) demonstrates that the majority of the damage was concentrated in southern Lebanon and northern Galilee (Fig. 3). Severe damage did not extend to localities south of the Nablus region.[14] According to contemporary sources the earthquake in Jerusalem was only felt (Shklov 1837) and caused limited damaged (Calman 1837; Nee'man 1837). Thus, we may assume that the al-Nabi Da'ud minaret was left untouched during this event. On the other hand, the 1834 earthquake did affect central Palestine (Fig. 3) and also badly damaged structures in Jerusalem (Ambraseys 2009, 642 and references therein). Therefore we suggest identifying the damaged minaret that was reported by Neophytus (Spyridon 1938, 92) with the al-Nabi Da'ud. This event is probably the only known earthquake between 1833 and 1838 that was destructive enough to partly demolish the minaret.

Knowing that the minaret was prone to earthquake damage, one may wonder whether it was damaged also prior to the 1834 earthquake. Since its establishment at the beginning of the sixteenth century, four destructive events struck Palestine prior to 1834. The two events of 1759 (Ambraseys and Barazangi 1989) and the 1588 earthquake (Ambraseys 2009, 467) affected localities in northern and southern Palestine, respectively, but were not reported to have caused any damage in Jerusalem. The 1546 earthquake, however, did affect Jerusalem, but according to Ambraseys and Karcz (1992), only damaged the bell tower of the Church of the Holy Sepulchre.

We cannot conclude why the al-Nabi Da'ud minaret was not reconstructed to its original height. Whether this was for fear of subjecting it to repeated failure in future events, because of low financial support, or merely because of technical difficulties is not known. In one way or another, the partial reconstruction has proved to be effective; during the 1927 Jericho earthquake that affected the entire Jerusalem area (Avni 1999), the minaret stood firm and suffered no damage.

ACKNOWLEDGEMENTS

We would like to thank Prof. Rachel Milstein and Dr Katia Cytrin-Silverman from the Hebrew University of Jerusalem, Amit Ree'm and Architect Avi Mashiah from the Israel Antiquities Authority, Engineer Yaakov Schaffer, Nir Ortal, and Dr Amnon Ramon from Yad Ben-Zvi institution, Hana Bendcowsky from the Jerusalem Center for Jewish-Christian Relations and Galia Richler-Grabler from the National Library of Israel for their assistance and constructive comments. We also would like to thank Beverly Kats for useful editing of the manuscript. The research was funded by the Ministry of National Infrastructures (grants #210–17–006, #29–17–043), the Amiran Prize of the Hebrew University and Yanai't Ben-Zvi scholarship of Yad Ben-Zvi institution.

NOTES

[1] The function of the minaret as an Islamic symbol evolved in two stages: During the Abbasid and Umayyad periods, the minaret was strictly a tower attached, in most cases, to an existing mosque and provided the Muezzin with a distinctive location to call for the prayer. By the beginning of the thirteenth century; however, minarets were built apart from the mosques and gradually became to be merely an Islamic symbol. As such, their height and location are two important characteristics (Bloom 1989, 175–91).

[2] The exact date of the earthquake is somewhat uncertain because the historical sources report different dates. The contemporary Neophitus dated the event to Sunday, May 13th at six o'clock in the morning

(Spyridon 1938, 92). Since Neophitus was a Greek-Orthodox monk from the Mar-Saba monestary, we assume he used the Julian calendar that corresponds to 25 May 1834. Menahem Mendel of Kamieniec (1800–73) dates the event to the 30th count of the Jewish 'Omer'. That is, the Hebrew date of Iyyar, 14th which corresponds to the Gregorian date of Friday, 23rd of May (Mendel 1839). He also notes that there were two tremors: one at noon and the second at night (Mendel 1839). Ambraseys (2009, 642 and references therein) dates the event to May 26th at 13:00 which corresponds to the siege of Jerusalem by the Fellahin (Hoffman 1963, 370).

[3] Burgoyne (1990, 41) follows Neophitus' testimony and concludes damage to one of the Mamluk minarets in the Old City. However, he does not indicate which minaret he refers to.

[4] The technique of supporting old buildings in Jerusalem by pairs of iron anchors was widely used, mainly in pre-20th structures (Michaeli 1928). These anchors were also used to strengthen damaged buildings after the 1927 Jericho earthquake (Willis 1927; Zohar *et al.* 2014).

[5] The itinerary of Benjamin of Tudela took place sometime between *c.*1165–73 and included Europe, the Middle East and northern Africa.

[6] Niebuhr's drawing was published in 1837 but was drawn already in 1776.

[7] Comte Louis Nicolas Philippe Auguste de Forbin (1771–1841) had visited Palestine in 1817–18 during which he had drawn Jerusalem's view from the east (Ben-Arieh 1997, 38).

[8] Catherwood (1799–1855) and Arundale (1807–53) travelled in 1833 together with Yosef Bonomi. Their trip was long and included Egypt, Sinai, and Palestine (Ben-Arieh 1997, 46).

[9] The drawing is included within the third of three volumes of drawings of Palestine that were published by the Finden brothers in 1836. For further details see Ben-Arieh (1997, 42–44; Ben-Arieh 2001, 116–19).

[10] Bartlett had visited Palestine only four years later in 1842 and also in 1853 (Vilnay 1965, 24). For this drawing he used a sketch made by Thomas Allum who in turn, visited Jerusalem during the summer of 1838 (Ben-Arieh 1997, 72).

[11] In his single travel to Palestine, Roberts arrived to Jerusalem on March 29th 1839. He left on April 25th of that year and headed back to London via Alexandria, Egypt (Ben-Arieh 1997, 99).

[12] Pierotti was an Italian military engineer and artist who resided in Palestine between 1854 and 1861. His sketches and drawings are counted as accurate and highly reliable (Ben-Arieh 1997, 56).

[13] Alud and Hillenbrand (2000, 346) suggest that the short shaft of the minaret is due to the fact that Jerusalem was and still is prone to destructive earthquakes.

[14] Besides Jerusalem, the following localities that are located south of the Nablus region were mentioned in the sources: Jaffa and Ramla where the earthquake was only felt; in the Moab region it caused only sporadic damage to old sites in Dhiban; and in Hebron and Gaza the shock was weak and caused only slight damage (Ambraseys 1997).

BIBLIOGRAPHY

Alud, S., and Hillenbrand, R., 2000. *Ottoman Jerusalem: The Living City, 1517–1917*. London: Altajir World of Islam Trust.

Ambraseys, N. N., 1997. 'The earthquake of 1 January 1837 in Southern Lebanon and Northern Israel', *Annals of Geophysics* 11, 923–35.

Ambraseys, N. N., 2009. *Earthquakes in the Mediterranean and Middle East: A Multidisciplinary Study of Seismicity up to 1900*, Cambridge: Cambridge University Press.

Ambraseys, N. N., and Barazangi, M., 1989. 'The 1759 earthquake in the Bekaa Valley - implications for earthquake hazard assessment in the Eastern Mediterranean Region', *Journal of Geophysical Research-Solid Earth and Planets* 94. B4, 4007–13.

Ambraseys, N. N., and Karcz, I., 1992. 'The earthquake of 1546 in the Holy Land', *Terra Nova* 4, 253–62.

Arundale, F., 1837. *Illustrations of Jerusalem and Mount Sinai including the most interesting sites between Grand Cairo and Beirout*, London: H. Colburn.

Asher, A. (ed.), 1927. *The Itinerary of Rabbi Benjamin of Tudela*. New York: A. Asher Co.

Avni, R., 1999. *The 1927 Jericho Earthquake: Comprehensive Macroseismic Analysis based on Contemporary Sources* (unpublished PhD Thesis), Ben Gurion University, Beer-Sheva.

Balmar, J., 1835. 'Mount Zion from a sketch on the spot by F. Catherwood, 1833', in T. H. Horne (ed.), *The Biblical Keepsake, or, Landscape Illustrations of the Most Remarkable Places Mentioned in the Holy Scriptures*, Vol. 3, London: John Murray.

Bartlett, W. H., 1838. 'Jerusalem from Olive Mt (after sketch by Thomas Allom)', in W. H. Bartlett, W. Purser, & Co., Syria, the Holy Land, Syria Illustrated with Description of the Plates by John Carne, London: Fisher, Son, & Co.

Bartlett, W. H., 1844. *Walks about the City and Environs of Jerusalem*, London: A. Hall, Virtue & Co.

Bartlett, W. H., 1855. *Jerusalem Revisited*, London: A. Hall, Virtue & Co.

Ben-Arieh, Y., 1970. *The Discovery of the Holy Land in the Nineteenth Century*, Jerusalem: Carta Jerusalem & the Israel Exploration Society (Hebrew).

Ben-Arieh, Y., 1973. 'The first maps of Jerusalem in the 19th century', *Eretz Israel* 1, 54–74 (Hebrew).

Ben-Arieh, Y., 1974. 'The Catherwood map of Jerusalem', *The Quarterly Journal of the Library of Congress* 3, 150–60.

Ben-Arieh, Y., 1977. *A City Reflected in Its Times - Jerusalem in the Nineteenth Century*, Jerusalem: Yad Izhak Ben-Zvi Publications (Hebrew).

Ben-Arieh, Y., 1979. *A City Reflected in Its Times. New Jerusalem - the Beginnings*, Jerusalem: Yad Izhak Ben-Zvi Publications (Hebrew).

Ben-Arieh, Y., 1986. 'The Western Travelers Books to Eretz Israel in the 19th Century', *Cathedra* 40, 159–88 (Hebrew).
Ben-Arieh, Y., 1997. *Painting the Holy Land in the Nineteenth Century*, Jerusalem: Yad Izhak Ben-Zvi Publications.
Ben-Arieh, Y., 2001. The View of Eretz Israel as Reflected in Biblical Painting of the 19th Century, in R. Aharonson and H. Lavsky (eds.), A Land Reflected in Its Past, Jerusalem: The Hebrew University Magness Press and Yad Izhak Ben-Zvi Press, 255–79 (Hebrew).
Benjamin, of Tudela, *c.*1165–73. *The Itinerary of Rabbi Benjamin of Tudela*, B. Bar-Yona (ed.), London and Berlin: A. Asher Co.
Bloom, J. M., 1989. *The Minaret: Symbol of Islam*, Oxford: Oxford University Press.
Bonfils, F., 1877. *Souvenirs d' Orient: Album pittoresque des sites, villes et ruins les plus remarquables de la Terra-Saints*, Alès: Chez l'auteur.
de Bruyn, C., 1698. Ierusalem. door de vermaardste deelen van Klein Asia, de eylanden Scio, Rhodus, Cyprus, Metelino, Stanchio, &c. mitsgaders de voornaamste steden van Ægypten, Syrien en Palestina, Delft: Henrik van Krooneveld.
Burgoyne, M. H., 1990. *Mamluk Jerusalem*, Jerusalem: World of Islam Festival Trust.
Calman, S. E., 1837. *Description of Part of the Scene of the Late Earthquake in Syria*, London: James Darling.
Cohen, A., 1982. 'The explusion of the franciscans from Mount Zion in the early Ottoman period - a reassesment', *Cathedra* 22, 61–74 (Hebrew).
Dogangum, A., et al., 2008. 'Investigation of dynamic response of masonry minaret structures', *Bulletin of Earthquake Engineering* 6, 505–17.
Fabri, F., 1480–83. The Book of the Wanderings of Brother Felix Fabri, A. Stewart (ed.), London: Palestine Pilgrims' Text Society.
de Forbin, L. N. P. A., 1819. *Voyage dans le Levant en 1817 et 1818 / par M. le C.te de Forbin*, Paris: Delaunay.
Hasselquist, F., 1766. *Voyages and Travels in the Levant in the Years 1749, 50, 51, 52*. London: L. Davis and C. Reymers.
Henniker, F., 1823. 'Jerusalem from the Cave of the Apostles on the Mount of Olives (1822)' in Notes during a visit to Egypt, Nubia, the oasis Boeris, Mount Sinai and Jerusalem. London: J. Murray.
Hinzen, G. K., 2013. 'Support of Macroseismic Documentation by Data from Google Street View', *Seismological Research Letters* 84, 982–90.
Hoffman, I., 1963. Muhamd Ali in Syria (unpublished PhD thesis), Hebrew University of Jerusalem, Jerusalem (Hebrew).
Ish-Shalom, M., 1965. *Christian Travels in the Holy Land: Description and Sources on the History of the Jews in Palestine*, Tel Aviv: Am Oved Publishers (Hebrew).
Jacoby, D., 1986. 'The Franciscans, the Jews and the issue of Mount Zion in the fifthteen century–a reconsideration', *Cathedra* 39, 51–70 (Hebrew).
Karniel, G. and Enzel, Y., 2006. 'Dead Sea Photographs from the Nineteenth Century', in Y. Enzel, A. Agnon, and M. Stein (eds.), *New Frontiers in Dead Sea Paleoenvironmental Research*, Boulder, CO: Geological Society of America, 231–40.
Layish, A., 1985. 'Waqf and sufi settlements in Eretz Israel at the early ottoman Period', *Cathedra* 35, 17–35 (Hebrew).
Mayer, L., 1804. 'Jerusalem' in Views in Palestine, from the Original Drawings of Luigi Mayer, with an Historical and Descriptive Account of the Country, and its Remarkable Places. London: R. Bowyer.
Mendel, M., 1839. *The Book 'Korot Ha'etim li-Yeshurun' in Eretz Israel*, Jerusalem: Yad Yitshaq Ben Zvi (Hebrew).
Michaeli, C. E., 1928. 'Notes on the Earthquake', *Construction and Industry* 11–12, 9–12.
Modena, C., Lorenzoni, F., and Schaffer, Y., 2010. *Seismic Assesment of the Monumental Historical Complex on Mount Zion ('Tomb of David' and 'Cenaculum')*, Jerusalem: Israel Antiquities Authority.
Motosaka, M., and Somer, A., 2002. 'Ground motion directionality inferred from a survey of minaret damage during the 1999 Kocaeli and Duzce Turkey earthquakes', *Journal of Seismology* 6, 419–30.
Nee'man, A., 1837. 'Arieh Nee'man's Letter from Safed to Amsterdam about the Earthquake in Safed', in A. Ya'ari (ed.), Letters of Eretz Israel, Tel-Aviv: Gazit, 363–67 (Hebrew).
Nemer, T., and Meghraoui, M., 2006. 'Evidence of Coseismic Ruptures along the Roum fault (Lebanon): A Possible Source for the AD 1837 Earthquake', *Journal of Structural Geology* 28, 1483–95.
Niebuhr, C., 1837. 'Prospect der Stadt Jerusalem vom Oelberge', in *Reisebeschreibung nach Arabien und den umliegenden Ländern*, Hamburg: Friedrich Perthes.
Nir, Y., 1985. 'The beginings of photography in the Holy Land', *Cathedra* 38, 67–80 (Hebrew).
Oliveira, C. S., et al. 2012. 'Minaret behavior under earthquake loading: the case of historical istanbul', *Earthquake Engineering and Structual Dynamics* 41, 19–39.
Pierotti, E., 1864. 'Mount Zion', transl.T. G. Bonney , *Jerusalem Explored: being a description of the ancient and modern city, with numerous illustrations consisting of views, ground plans and sections*, London: Bell and Daldy.
Pococke, R., 1745. *A Description of the East and Some Other Countries*, London: Bowyer, W.
Praver, Y., 1947–48. 'The friars of Mount Zion and the Jews of Jerusalem in the XVth century', *Yedi'ot ha-Hevrah la-Hakirat Erets-Yisra'el ve-'Atikoteha* 14, 15–24 (Hebrew).
Quaresmius, F., 1639. *Novae Ierosolymae et locorum circumiacentium accurata imago*. Quaresmius, Franciscus. Historica, theologica et moralis Terrae Sanctae elucidation, Vol. 2, Antwerp: Balthasar Moreti.
Re'em, A., 2012. 'Jerusalem, Mount Ziyyon', *Hadashot Arkheologiyot* 124, 1–8.
Roberts, D., 1842–1849. *The Holy Land, Syria, Idumea, Arabia, Egypt & Nubia. Drawings made on the spot by David Roberts, R.A. With historical descriptions by the Rev. George Croly, L.L.D. Lithographed by Louis Haghe*, Vol. 1, London: F. G. Moon.

Röhricht, R., 1890. *Bibliotheca Geographica Palaestinae : chronologisches Verzeichnis der von 333 bis 1878 verfassten Literatur über das Heilige Land*, London: John Trotter Publishers.
Rose, G., 2000. 'Practicing photography: an archive, a study, some photographs and researcher', *Journal of Historical Geography* 26, 555–71.
Rose, G., 2001. *Visual Methodologies: An Introduction to Interpretive Visual Materials*, London: Sage.
Rubin, R., 2006. 'One city, different views: a comparative study of three pilgrimage maps of Jerusalem', *Journal of Historical Geography* 32, 267–90.
Seetzen, U. J., 1854–59. Ulrich Jasper Seetzen's Reisen durch Syrien, Palästina, Phönicien, die Transjordan-Länder, Arabia Petraea und Unter-Aegypten. Berlin: G. Reimer.
Sezen, H., et al. 2008. 'Dynamic analysis and seismic performance of reinfored concrete minartes', *Engineering Structures* 30, 2253–64.
Sezen, H., and Dogangum, A., 2012. 'Seismic Performance of Historical and Monumental Structures', in H. Sezen (ed.), *Earthquake Engineering*, 181–02, DOI: 10.5772/51338.
Shklov, I., 1837. 'Israel of Shklov's Letter from Jerusalem to Amsterdam about the Earthquake in Safed', in A. Ya'ari (ed.), *Letters of Eretz Israel*, Tel-Aviv: Gazit, 357–63 (Hebrew).
Spyridon, S. N., 1938. 'Annals of Palestine: 1821–1841', *Journal of the Palestine Oriental Society* 18, 63–132.
Tirion, I., 1732. *Jerusalem, zoo als het tegenwoordig is. Salmon, Th. and M. van Goch*, Hedendaegsche historie of … alle Volkere. Amsterdam: Isaak Tirion.
Turner, W., 1820. *Journal of a Tour in the Levant*, Vol. 2, London: John Murray.
Vilnay, Z., 1965. *The Holy Land in Old Prints and Maps*, Jerusalem: Rubin Mass.
Vincent, H. and Abel, F. M., 1922. *Jerusalem Recherches de Topographie, D'archeeolgie et D'histoire*. Paris: Librairie Victor Lecoffre.
Willis, B., 1927. *To the Acting High Commissioner Lt-Col. G.S Symes*, 2–7, British National Archives: CO 733/142/13.
Zohar, M., Rubin, R., and Salamon, A., 2014. 'Earthquake Damage and Repair: New Evidence from Jerusalem on the 1927 Jericho Earthquake', *Seismological Research Letter* 85, 912–22.
Zohar, M., Salamon, A., and Rubin, R., 2013. *Damage Patterns of Past Earthquakes in Israel – Preliminary Evaluation of Historical Sources*, Jerusalem: Geological Survey of Israel.