The earthquake of 1 January 1837 in Southern Lebanon and Northern Israel

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Abstract
All of our 20th-century information for the Levant Fracture and Dead Sea transform fault systems is for a quiescent period in the seismicity. This is apparent when we consider earlier events which show that infrequent earthquakes have occurred in the past along this system, an important consideration for the assessment of hazard and tectonics of the Middle East. One of these events was the earthquake of 1837 which caused heavy damage in Northern Israel and Southern Lebanon. This earthquake was a much larger event than earthquake catalogues indicate. We reckon it was a shallow, probably multiple event of magnitude greater than 7.0.

Key words *seismicity – Middle East – historical earthquake – magnitude*

1. Introduction

In previous papers we have shown that relatively large but infrequent earthquakes have occurred in the past along the Dead Sea transform fault system or Levant Fracture, and consequently that all our 20th-century information for this tectonic system are for a quiescent period in the seismicity (Ambraseys and Barazangi, 1989; Ambraseys and Melville, 1988, 1995).

One of the events of the pre-instrumental period that must be added to the large events belonging to the Dead Sea fault system is the earthquake of 1 January 1837. This event is listed in a number of catalogues (Colla, 1837; Perrey, 1850; Mallet, 1854; Lemmens, 1898; Arvanitakis, 1903; Willis, 1928; Sieberg, 1932a,b; Kallner-Amiran, 1951). Modern writers locate the event just north of Safed in Israel and assign to it a magnitude of 6.4 (Vered and Striem, 1976, 1977; Ben-Menahem, 1979; Amiran *et al.*, 1994).

However, a re-appraisal of the available information suggests that this was a larger earthquake with an epicentral area that extended to the north, well beyond Safed into Lebanon, and that it was associated not only with the pull-apart basins of the Galilee Sea and Hule depressions but probably also with a part of the braided Roum fault which further to the northwest traverses the less frequented districts of Bshara, Marjuyum and al-Tuffa (Touffa), figs. 1 and 2.

The information for this earthquake comes from contemporary sources such as unpublished consular correspondence, official documents and damage returns (M1 to M6), as well as from press reports (P1 to P6) and from the observations of travellers who passed through the epicentral region after the earthquake. Some of these observations are summarised by Kitto (1844).

At the time of the earthquake Palestine and Syria, parts of the Ottoman empire, were occupied by the Egyptians (1831-1840) and the region was in turmoil. This, to some extent, ac-

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counts for the dearth of information from the hinterland and from Turkish archives in Istanbul, although for the latter search has been rudimentary. Also no documents could be found in Melkite repositories relating to the effect of this event on monasteries in the Shouff region in Lebanon except for the personal communication from Archimandrite Euthymius Skaf, that he was not aware of any documents relating to damage to Melkite property caused by the 1837 earthquake.

Appendix gives in some detail the macroseismic information for this event, much of which is not readily available to readers. Figure 1 shows the area over which the shock was felt and fig. 2 the location of the sites affected in the epicentral region.

2. The earthquake of 1 January 1837

The earthquake occurred on 1 January 1837 at about four in the afternoon and lasted about 20 s. It was probably a multiple event, the second shock occurring about five minutes after the main shock.

Destruction or heavy damage was done along a relatively narrow zone which extended from the coastal area of Saida (Sidon) through the inland iklimi (regions) of al-Touffa, Marjuyum, Bshara to Lake Tiberias, for a lotal length of about 120 km, fig. 3. Damage in the epicentral region was widespread and varied from place to place over short distances. Much of it can be attributed to the high vulnerablity of the local type of houses and also to the siting of villages, particularly those in the central and north part of the affected area. A general observation about a typical rural house in Syria and Palestine in the early 1800s is that its inherent strength was very low and extremely variable, and its vulnerability to earthquakes high. Local houses were chiefly one-storey high, of rubble masonry construction covered with heavy flat roofs, already in a ruinous state. The degree of damage or destruction caused by an earthquake was usually proportional to the size of the housing conglomerate or village; the larger the conglomerate, the heavier the apparent damage. The high vulnerability of local houses becomes apparent when we consider the relatively small damage sustained by the few properly built public structures in the epicentral region, such as convents, churches, walls and bridges, as compared to ordinary dwellings.

Another factor that contributed to the erratic distribution of damage in this and other earthquakes before and after 1837 in this region, is site effects. Many villages, for defense reasons, were built on hilltops or on steep slopes, overlooking their fields. Many of these sites have had already suffered from slides and regional instability of the ground, particularly those built on marls, chalk and weathered limestone. The destruction of Safed, for instance, and of the nearby villages of Ein Zeitim, Reina and Jish in the earthquake of 1837 can be attributed to the instability of their sites rather than to the exceptional severity of the shock (Wachs and Levitte, 1981). Regarding the loss of life, the earthquake happened in the evening, during a wet period in winter when most people were indoors having dinner, which contributed to the relatively large number of casualties.

These factors make the assessment of intensity difficult and for many sites in the epicentral region its maximum value appears to be effectively the same, that is, it saturates at about intensity VII-VIII MSK, and all local houses are destroyed and any village would thus appear equally, but no more devastated at higher intensities. For lower intensities, which in our case come chiefly from urban areas, there is always an element of exaggeration which has to be taken into consideration (Striem, 1983).

Figures 1 and 3 summarize the far- and near-field effects of the earthquake. With the exception of the epicentral region shown in these figures, to the west of it the Mediterranean Sea and to the east a sparcely populated tribal area provided no macroseismic information. This is a typical feature of earthquakes in the region that results in biasing isoseismals of earthquakes of all magnitudes greater than about 5.5 to be drawn elongated in a north-south direction.

Figure 1 shows that the shock was felt within a radius of about 500 km and that at large distances it caused long-period effects,

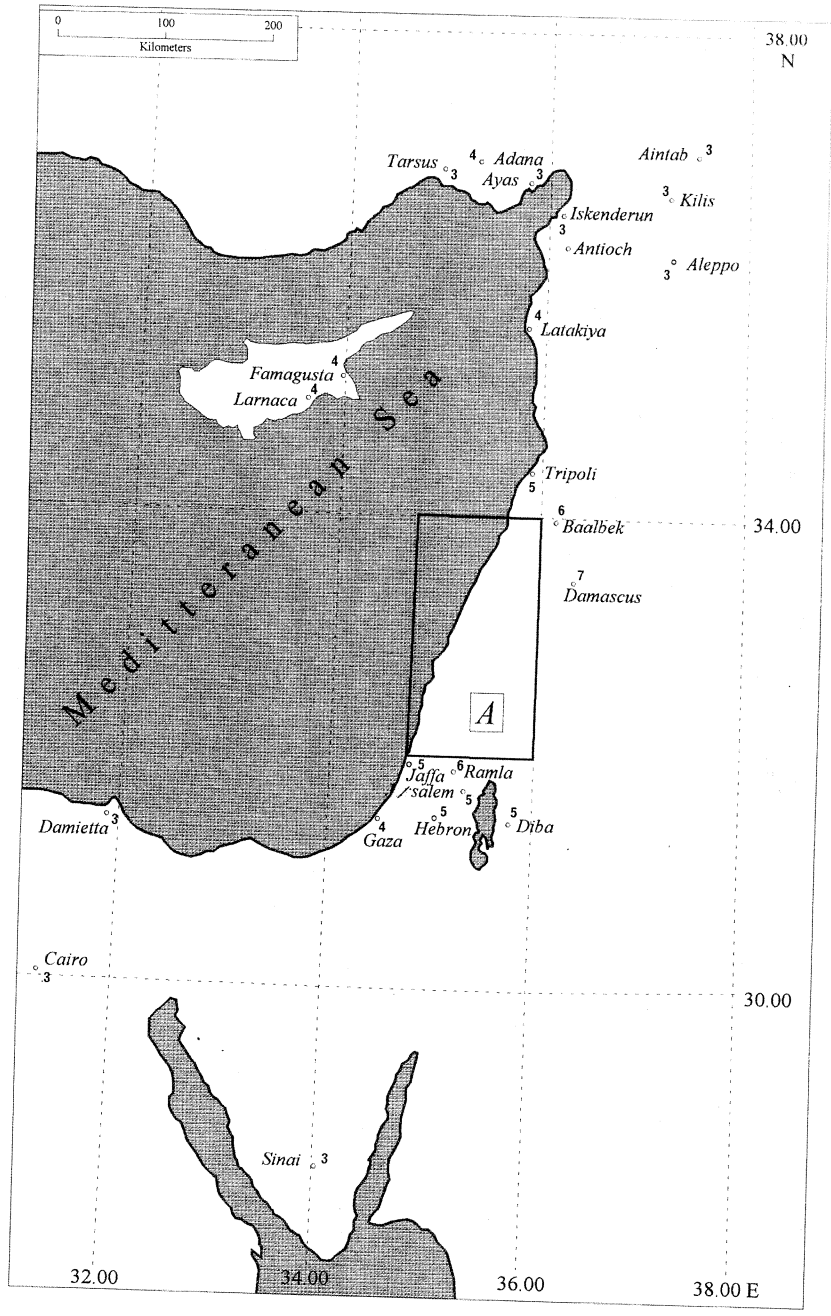
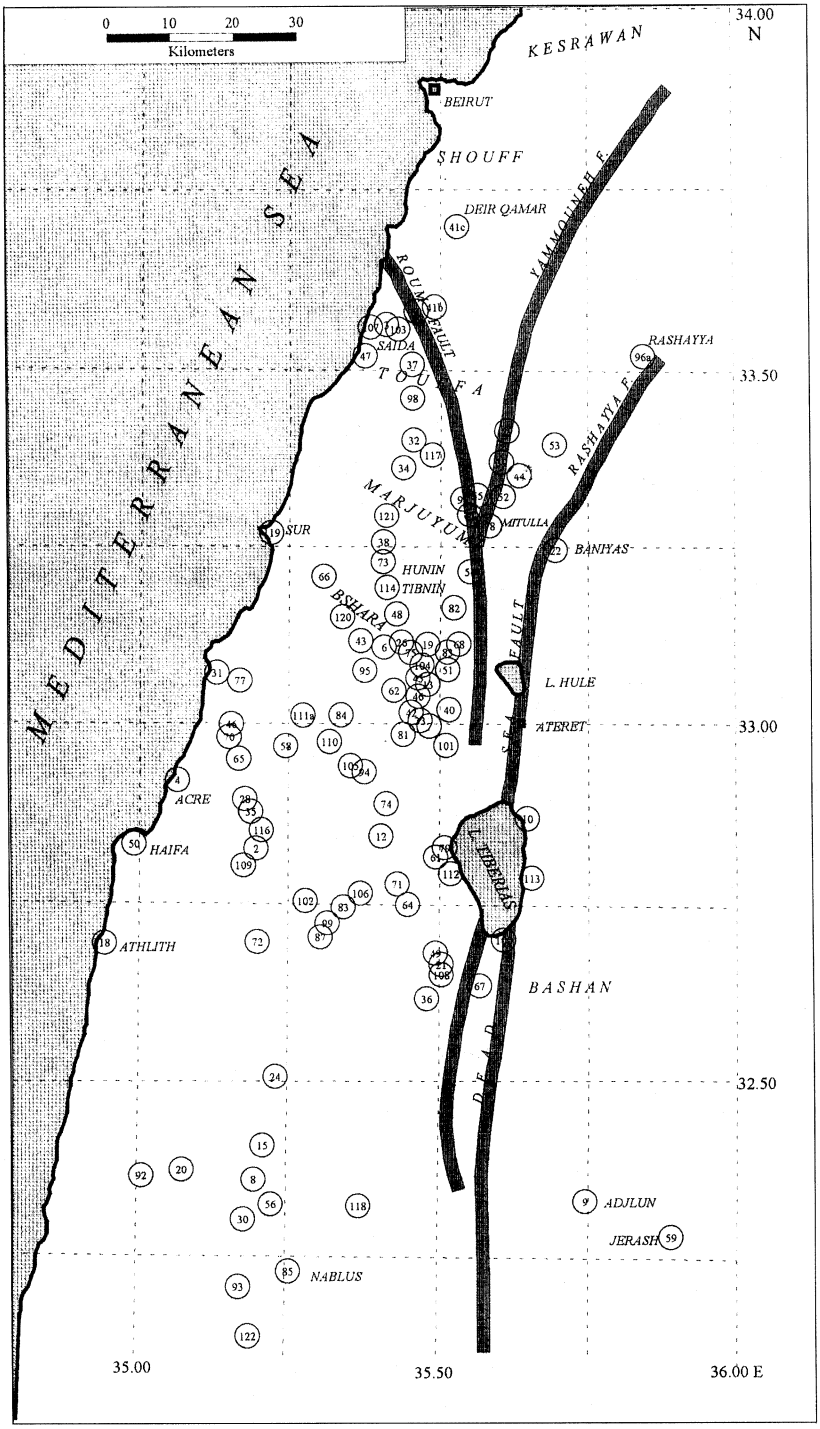


Fig. 1. Geographical map of the region in which the 1837 earthquake was felt. Locations shown are those in which the shock was felt. Numbers are intensity ratings, in the Medvedev-Sponheuer-Karnik scale, due to the main shock. Blank inset A is the location of the epicentral region shown in fig. 2.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YAMMOUNEH F.
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TOUFFA
RASHAYYA
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MARJUYUN
MITULLA
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BANIYAS
HUNIN
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BSHARA
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L. TIBERIAS
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BASHAN
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such as slow and sustained oscillations of the ground and nausea, common far-field characteristics of large earthquakes.

In the near-field the assessment of intensity is complicated owing not only to the high vulnerability of local dwellings and site effects mentioned earlier but also due to the possibility that the reported macroseismic effects and damage are due to two successive, relatively large magnitude, events. A double shock, with separate epicentres, would have affected significantly the observed distribution of damage in the epicentral area but it would have little effect on the distribution of intensity at large distances. The available macroseismic data do suggest sub-events but it is not possible to say which parts of the zone were associated with them.

3. Assessment of magnitude

There are no earthquakes of size comparable to that of the 1837 earthquake in the Dead Sea zone in the instrumental period – after 1898 – that can be used to calibrate the magnitude of this event using macroseismic data.

We may use the relationship derived to predict surface wave magnitudes from macroseismic data of Turkish and North Syrian earthquakes, *i.e*

$$M_s = -1.74 + 0.66\,(I_i) + 0.0015\,(r_i) + \\ + 2.26 \log (r_i) + 0.25\ p \qquad (3.1)$$

where $r_i = (R^2 + 7.4^2)^{0.5}$ and R_i is the average radius of isoseismals of intensity I_i. The last term p in equation is zero for mean values and +1 for plus one standard deviation (Ambraseys and Finkel, 1986,1987)

Equation (3.1) has been derived from 523 isoseismals belonging to 158 shallow earthquakes in Turkey up to 1995, with M_s magnitudes in the range 4.0 to 7.8 and isoseismal radii from 5 to 800 km. The smallest intensity used is III and the maximum VIII (MSK). Equation (3.1) is an unpublished improved version of a very similar relationship derived for the same area for events up to 1986.

Fig. 2. Location map of the epicentral region of the 1837 earthquake (inset A in fig. 1) showing trend of main faults (shaded). Numbers refer to locations affected given below in alphabetical order: 1: Abagha (?); 2: Ablayin; 3: Abra; 4: Acre; 5: al-Afrish (?); 6: Ain Ibli; 7: Ain Zeitun; 8: Ajja; 9: Ajlun; 10: 'Akib, Kafr; 11: Algar (Mugar ?); 12: A(i)labun; 13: Alma; 14: Amba (?); 15: Arraba; 16: al-Asban (?); 17: Atbar (?); 18: Athlith; 19: A(y)t(a)run; 20: Attil; 21: A(u)lam; 22: Banyas; 23: Bashmahr (?); 24: Bilad Harithiya; 25: Bilad Shaqif (n. Qalat Shuqf); 26: Bint Jubayl; 27: Bira (= Kafr Birim); 28: al-Birwa; 29: Beka'a; 30: Berqa; 31: Betset; 32: Caffar (= al-Kufur); 33: Cudittha (= Qaddita); 34: Djibshit; 35: D(a)mun; 36: Danna; 37: Dar al-Hatta; 38: Deir Qufa: 39: Dibbin; 40: D(a)llata; 41: Deir Mimas; 41b: Deir al-Mukhalles; 41c: Deir Qamar; 42: Djish (= Jish); 43: Dibil; 44 E(i)rbil (Ibel), Kherbet Shaqa; 45: al-Fara; 46: Ghabsiyya; 47: al-Ghaziye; 48: Giahun (Beit Yahun); 49: Hadatha; 50: Haifa; 51: (H)Deishun; 52: al-H(Kh)iyam; 53: Hashbaya; 54: Hunnin; 55: al-Hurba; 56: Jaba; 57: Jaba (near Haifa ?); 58 Jatt; 59: Jerash; 60: Jun; 61: Irbid; 62: Kafr Bir'im; 63: Kafr Kenna; 64: Kafr Sabt; 65: Kafr Yasif; 66: K(Q)ana; 67: Kherbet Beka'a; 68: K(Q)adas; 70: Kaweikat; 71: Lubiya; 72: Ma'lun; 73: Marun; 74: Maghar; 75: Marun al-Ras; 76: Mashariq (?); 77: Ma'soub(kh); 78: Mitulla; 79: Mijdal; 80: Majael (?); 81: Meirun; 82: al-Mays; 83: Melikiyeh; 84: Msabla (?); 85: Nablus; 86: Najarieh (?); 87: Nazareth; 88: Nisable (?); 89: Ontilias river (Wad'Iliyas); 90: Qala't al-Shubeibeh (near Banyas); 91: Qala't al-Shuqf; 92: Qaqun; 93: Qaryat Jit; 94: Rama; 95: Ramaysh; 96: Rashaya; 97: Ras al-Ahmar; 98: Rumin: 99: R(u)eina; 101: Safed; 102: Saffuriya; 103: Salihiyah; 104: al-Salha (Yiron ?); 105: Shezor; 106: Shadjara; 107: Sidon region; 108: Sirin; 109: Shefar'am; 110: Sumei; 111: Sutli (?): 111a: Tarshiha; 111b: Tel Bisha (near Jit/Nablus); 112: Tiberias; 113: Tiberias East; 114: Tibnin; 116: T(i)amra; 117: al-Tahta Nabatiiya; 118: Tubas; 119: Sur (Sidon); 120: Ya'tar; 121: Zeqqieh; 122: Zeita. Because of lack of space not all sites are shown in fig. 2. The location of sites not shown can be deduced from the text. Sites not mentioned above but not shown in fig. 2, are sites of unknown location which are mentioned passim in the sources of information without details. Alternative spelling is given in brackets and a question mark indicates that the location has not been identified.

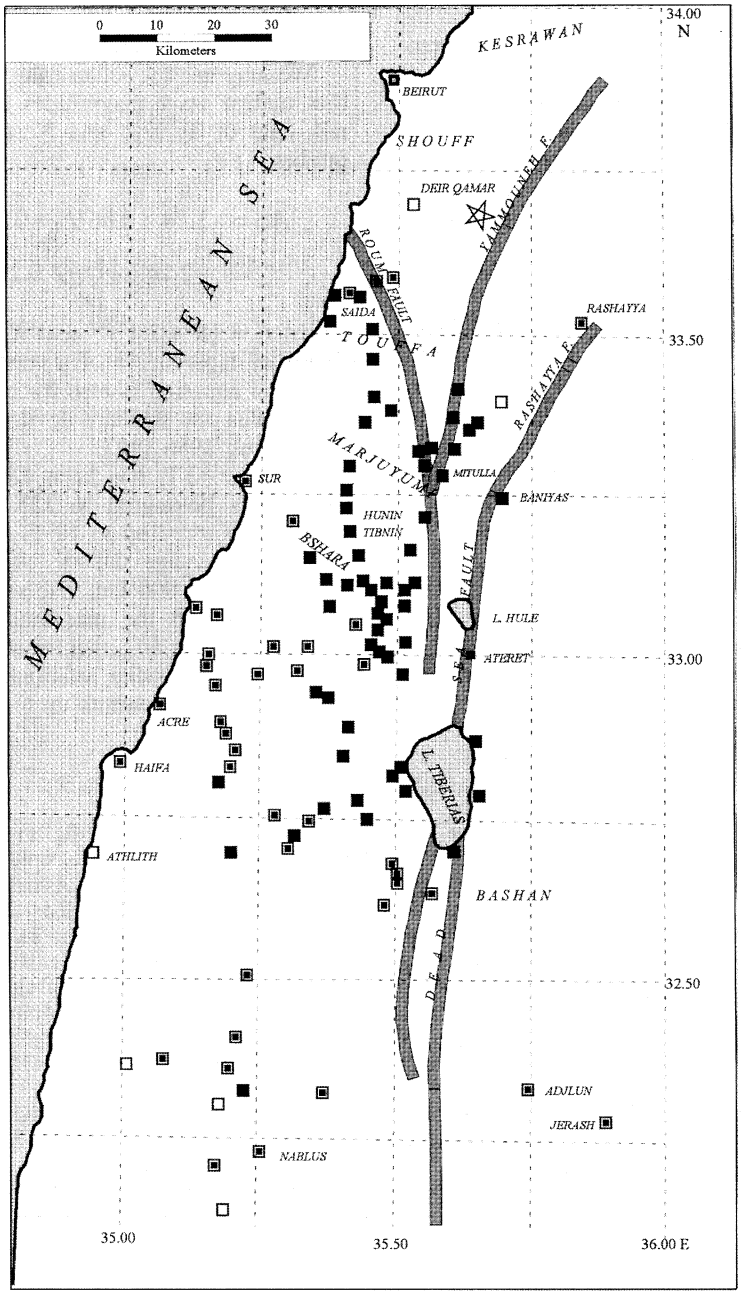

Fig. 3. Intensity distribution of the earthquake of 1837. Full, dotted and open squares show intensities assessed in this study of VIII, VII and VI MSK respectively. Star shows the preliminary location of the earthquakes of 26 March 1997 at 04 h 22 min and 13 h 20 min (UTC) of M_w = 5.1 and 4.9 respectively that occurred when this paper was in press.

On a comparative basis, the earthquakes of 1202 (Ambraseys and Melville, 1988) and 1756 (Ambraseys and Barazangi, 1989) were larger than the 1837 earthquake. The former was associated with the Yammouneh fault and with its junction with the Dead Sea fault and had a magnitude perhaps larger than 7.6. The shock of 1756 was also associated with the Yammouneh fault and from eq. (3.1) its magnitude should be about 7.5.

Figure 3 shows our estimate of the near-field distribution of intensity. Solid squares show sites at which intensities approached or exceeded VIII (MSK). Squares within a square indicate intensities of about VII (MSK), and open squares are for intensities of about VI (MSK). Figure 1 shows our assessment of intensities in the far-field.

In the absense of data for intensities smaller than VI to the east and west of the epicentral area, we used the values of the radii $r(i)$ that obtain from data in the north-south direction which are: $r_3 = 530$ km, $r_4 = 300$ km, $r_5 = 200$ km, $r_6 = 130$ km, $r_7 = 70$ km, $r_8 = 35$ km. From these figures eq. (3.1) gives a magnitude of $M_s = 7.1$. If we assume that lower (< VI), far-field isoseismals, have shapes of the same aspect ratio as those for (> VI), the magnitude from eq. (3.1) is $M_s = 7.0$.

4. Faulting

There remains to discuss the question of whether this earthquake was associated with surface faulting.

The three large aftershocks of this earthquake, on 16 January to the south end of the epicentral area, on 22 January near the middle of this area, and on 20 May in the north, in the region of Hasbeya (No. 53 in fig. 2, between the Yammouneh and Rashayya faults) define a source length of about 70 km, which is almost the same as the length of the long axis of the epicentral area shown in fig. 3 (full squares).

This alignment could easily be associated with rupture of the Roum fault and of its extension to Lake Tiberias in the south (Walley, 1988) or, alternatively, if the shock was double, it may well be associated with rupture of both the Roum and the Yammouneh faults. However, if it be assumed that the lack of evidence for destruction east of the Dead Sea and of the Rashayya faults shown in fig. 3 is genuine and not due to lack of data, the fact that destruction follows the Roum fault through al-Touffa to Saida (fig. 3) suggests the the Roum fault is a more likely candidate as the source of this earthquake than the Yammouneh fault. However, with no evidence for surface faulting in the literary sources there is no way of choosing between these two alternatives.

The only information regarding ground deformation associated with this earthquake is vague and inconclusive. Reports that near Safed the ground was «rent» and so did up to a point east of Jish and beyond as far as one could see, and also that large fractures in the ground opened up near Mitulla and likewise in the vicinity of Baniyas, may refer to features of a tectonic origin (M1; M2; Waghorn, 1837; Robinson, 1856); Anonymous (1843).

The reported cases of deep cracks opening up between Tiberias and Safed, emitting dust, seem to be due to landslides (M3; Robinson, 1856).

Also it was said that as a result of the earthquake the (west ?) coast of Lake Tiberias sank and that the lake water rose and swept away many people (M1; Macgregor, 1904). This observation on its own does not imply that this change of level of the coast was necessarily of tectonic origin. It may well have been a rather exaggerated observation relating to the rapid fluctuation of the level of the Lake noticed by Lynch (1852).

Another report by seamen that the westerly side of the shoreline at Sur had risen above the rocks and that this was clear proof of the subsidence of the ground caused by the earthquake cannot be substantiated (Bertou, 1843).

Equally inconclusive is the evidence for surface faulting at Ateret (Qasr al-A'thara), a Crusader fort on the western bank of the Jordan river just south of Jisr Banat Jaqub, fig. 2, where archaeological finds show that east-west walls of the fort have been clearly displaced in a left-lateral sense by 2.1 m by a north-south trending fault while more recent, Muslim, structures have been displaced by about 0.2 m

(Marco *et al.*, 1996). However it is not known when these displacements took place and there is no good reason to associate them with this earthquake.

If we assume that the earthquake was associated with faulting we may estimate its rupture length L from

$$M_s = 5.13 + 1.14 \log(L) \qquad (4.1)$$

where L is in kilometres. This equation has been derived from a straight forward orthogonal regression of M_s and $\log(L)$ from 62 shallow earthquakes in the Eastern Mediterranean and the Middle East associated with surface faulting, with 55% of the data coming from strike-slip, 30% from normal and 25% from thrust faults (Ambraseys, 1996).

The same data set and regression method show that the associated fault displacement u in centimetres can be obtained from

$$\log(u) = -2.99 + 0.73\ M_s. \qquad (4.2)$$

With an estimated magnitude of 7.1, eq. (4.1) gives a rupture length of 54 km, which is compatible with the length of the Roum fault, with an associated displacement, from (4.2), of 150 cm, estimates close to those that can be obtained from the global relations of Wells and Coppersmith (1994).

5. Conclusions

From the foregoing it appears that the 1837 earthquake was an event of magnitude greater than thought until now, and perhaps a multiple event, not dissimilar to earlier large earthquakes, consisting of two shocks, the macroseismic effects of which cannot be separated.

Maximum damage was experienced along the Roum fault and its small branches which occupy the regions of Marjuyum anf Bshara to the southwest (Freund *et al.*, 1970).

There is no conclusive field evidence that this earthquake was associated with surface faulting.

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Appendix

The main shock occurred on 1 January 1837 or on 24 Ramadan 1252 Hijri, at 10 min before sunset. The earthquake was reported from Beirut and other places at different local times between 16 h 35 min and 16 h 45 min. The main shock lasted between 10 and 30 s and eyewitness reports imply that the earthquake consisted of two distinct shocks about 5 min apart (M1; M5; M6; Moore, 1837).

Epicentral area

Referring to fig. 2, and starting from the north, in Beirut the earthquake caused panic but no serious damage in the city itself. About eight houses, built outside its walls on alluvium by the sea, collapsed killing two people (M1; Paxton, 1839; Rustum, 1942). No damage was reported from Kesrawan, a district north Beirut, and reports from the district of Shouff, south of the town, are lacking. The monastery of Deir Qamar was badly shaken and those of Deir al-Mukhalles and Jun were damaged but details are lacking.

Saida (Sidon) was almost totally ruined. Of its 1800 houses, 580 were demolished and 630 ruined with the loss of 7 lives. Qala't Mezzeh (Chateau de Saint Louis of the Crusaders), standing on the promontory which divides the two harbours, collapsed. The French khan (merchants'stores) fell and the walls of the town were breached. Because of its importance the town and its land-walls were rebuilt by Soleyman Pasha immediately after the earthquake (P1; P6; M1; M3; Thomson, 1837; Rustum, 1942; Kerhardene, 1859).

At al-Ghaziye 14 houses collapsed killing 7 people (M1). Further inland Abra and nearby Deir Mar Elias were seriously damaged (Lindsay, 1839; Meryon, 1845). Salihiyah, Dar al-Hatta and Rumin were totally destroyed (M1).

On the east side of the Bekaa Valley, at Rashaya, the shock was very violent but it is not known whether it caused any damage (Thomson, 1837). However, in the upper reaches of the Bekaa valley several villages were more than half destroyed and a khan, the name of which is not given, was thrown down killing 60 people (M1).

The shock was violent at Hashbaya where it is not known whether it caused any damage (Thomson, 1837). Caffar (al-Kufur) collapsed with the loss of 72 lives and so did Dibbin, Nabatiya al-Tahta and Djibshit (M1).

The large villages of Erbil and of nearby Kherbet Shaqa were completely destroyed and 100 people were killed. Also Khirbah and al-Hiyam fell; 5 people lost their lives in the former and 150 in the latter. In the region of Bilad al-Shuqf 600 goats were killed, presumably by rockfalls (M1).

Qala't al-Shuqf (the Chateau de Beaufort of the Crusaders), standing on a cliff where the Litani river turns towards the sea, was shattered and a part of the interior structure of the citadel collapsed killing 5 people (M1). Deir Mimas, where 5 people lost their lives, was totally destroyed and rebuilt immediately after the earthquake. About one third of the houses in Zeqqieh were destroyed and 8 people were killed (M1). Deir Qufa was totally ruined and in Mitulla nothing was left standing and 78 people lost their lives (M1).

Much of Banyas was ruined and some parts of the Qal'at al Shubeibe, which stands on the summit of a hill to the east of the village, collapsed. Also the roof of the nearby Grotto of Pan fell and not far from its vicinity a large rent was made in the ground (M2; Saulcy, 1854, 1955).

On the coast, Sur (Tyrus) suffered considerable damage; 40 houses, presumably old, on the islet at the entrance of the harbour, collapsed killing 16 and injuring 36 people. There is some evidence that as result of this earthquake the east coast of the north harbour slumped (M6; Thomson, 1837; Waghorn, 1837; Bertou, 1843; Prutz, 1876). Further inland the old castle of Hunin (the Chastel Neuf of the Crusaders) was shattered and much of its interior, including the mosque, collapsed, no structure remaining habitable (Guerin, 1880). There are no damage details for the districts of Hunin and Tibnin where it is said that 614 people were killed in 49 settlements. Half of some of them and likewise 5 water mills were totally destroyed together with a third of the inhabitants (P1; M6).

In this region, the villages of Abagha, al-Afrish, Amba, el-Asban, Atbar, Mugar and Sutli, are reported to have been ruined but I could not identify their location, either because their names have changed or they are misspelled in the various reports.

Marun was also totally estroyed and Kana was damaged (Thomson, 1837). One of the two parts into which al-Mays is divided collapsed killing 3 people (M1). Also Giahun (Beit Yahun) was totally ruined (M1). At Ya'tar 12 people were killed and Kadas was completely destroyed with the loss of 53 lives; also Melkiyeh was destroyed as well as near-by Atrun where 33 people were killed (M1; Calman, 1837).

Bint Jubayl was ruined with the loss of 8 lives, and at Ain Ibli houses collapsed causing the loss of 12 lives (M1). Another 17 people were killed at Marun al-Ras which was also ruined, while 30 people were killed and 10 injured at Ramaysh, and 12 lost their lives at al-Salha (M1; Calman, 1837; Thomson, 1837).

Dibil was almost totally destroyed and 12 people lost their lives (Calman, 1837). Three quarters of Heishun collapsed and 13 people were killed, and Alma was totally destroyed. In al-Fara 12 people perished (M1). Kafr Bir'im was badly damaged; the church and a row of columns and other standing remains of an early synagogue were thrown to the ground (M1; Thomson, 1837, 1859; Calman, 1837; Waghorn, 1837; Guerin, 1880).

At Ras al-Ahmar [96b] 40 people were killed and 12 injured (Calman, 1837). Djish was completely destroyed and not a house was left standing; the church fell killing 130 persons and the old walls of the town collapsed; in all 235 people were killed and in places the ground was fissured (Thomson, 1837; Waghorn, 1837; Robinson, 1856). Sabelan was totally ruined without casualties (M1). Also Tarshiha was likewise damaged without loss of life (M6).

Dallata, Caditta (Qaddita), and Ain Zeitun were almost totally destroyed (M1; Thomson, 1837). In contrast near-by Meirun suffered relatively little damage and the walls of the tombs of Rabbi Eleazer and Rabbi Shemaun were dislodged but did not collapse (Neman, 1971).

In Safed, the largest of the places affected, the north, Jewish section of the town was almost entirely destroyed while the south, Moslem, section suffered far less damage. The number of deaths reached 2158 of which 1507 were Ottoman subjects, Muslim or Jewish and 651 foreigners (P2; P6; M1; M2; M6; Thomson, 1837; Waghorn, 1837; Liebetrut, 1854; Guerin, 1880; Mitford, 1884). Nearby Rama was totally destroyed and 180 people were killed (M1; P7; Calman, 1837). Also in Shezor and in Jabal (the location of which has not been identified) 245 houses were destroyed, 563 damaged and 141 people killed (M1; M6).

Kafr Sumei was totally ruined. However, just west of these villages, Jatt was probably not seriously damaged (M1; Thomson, 1837), but much of Ailabun collapsed killing 25 people while Maghar was ruined (M1).

To the west at Acre only about 40 houses fell, 4 people were killed and several injured and the fortifications, already in ruins, were damaged. In the district of Acre the earthquake killed in all 141 people (M1; M6; P4; Waghorn, 1837).

There is no evidence that the villages of Tamra, Damun, al-Birwa, Kafr Yasif, Kaweikat, Ghabsiyya, Betset and Jatt were damaged (Thomson, 1837). Ablayin suffered relatively little and its minaret was left standing but in nearby Shefar'am 86 houses were ruined, 139 heavily damaged, 7 people were killed and 4 injured (M6; Thomson, 1837).

Mijdal, on the west coast of Lake Tiberias was destroyed and Irbid was totally ruined. The same happened to Kafr'Akib on the north-east coast of the Lake (M1; Thomson, 1837; Guerin, 1880). About two thirds of the houses in Tiberias, most of them built of stone masonry, together with a large part of the walls, the bazaar, minarets, the mosque and the church of St. Peter collapsed killing 822 people, of which 500 were Jews, 300 Moslems and 22 Christians, injuring 65. These figures may include casualties from 17 settlements in the environs which allegedly were destroyed but which are not named in the returns. The castle of Tiberias was ruined,

and its towers were caused to lean over. The baths, built in 1833, were not damaged but the yield of the hot spring and fountains increased temporarily. The town was not restored until after 1846 (M1; M6; Thomson, 1837, 1859; Shkelov, 1837; Olim, 1843; Montefiori, 1844; Furst, 1847; Beldam, 1851; Robinson, 1856, Pfeiffer, 1856; Frankl, 1858; Kerhardene, 1859; Jenner, 1873; Layard, 1887; Italiander, 1970).

Lubiya was totally destroyed and 143 people were killed (Thomson, 1837; Beldam, 1851). To the south, Kafr Sabt was ruined by the shock without loss of life (Guerin, 1880). Shadjara was also ruined and 50 people lost their life (Calman, 1837; Thomson, 1837). In constrast, Kafr Kenna suffered negligibly small damage and no loss of life; also Saffuriya and its church of Santa Ana escaped entirely with only little damage done to its ruined castle, while next to it, Reina was obliterated with the loss of about 200 lives (Calman, 1837; Thomson, 1837; Robinson, 1856).

Contrary to early reports damage in Nazareth was not excessive. Only one house collapsed and about one quarter of the dwellings in the town suffered different degrees of damage; a part of the hostel of the convent collapsed and an external cornice of the church of the Annunciation fell, killing 4 people. In all 7 people were killed. The reported destruction in the north-eastern part of Nazareth seems to be based on the cumulative losses reported from settlements in the whole of its district, already accounted for in the returns, that amounted to 373 houses destroyed, 425 ruined, 162 people killed and 13 injured (P1; P5; M1; M6; Thomson, 1837; Waghorn, 1837; Vissino, 1840; Schubert, 1840; Blondel, 1843; Russegger, 1847; Beldam, 1851; Robinson, 1856; Tobler, 1868).

South and southwest of Lake Tiberias the settlement of Simakh was also destroyed and 5 people were killed and the villages of Hadatha, Alam, Sirin, Kherbet Baka'a and Danna were partly ruined without loss of life (Waghorn, 1837; Guerin, 1880). Many villages in the region east of the Lake were likewise laid in ruins but details are lacking. In the district of Bashan, allegedly, fire was seen comimg out of the ground (Calman, 1837; Thomson, 1837; Robinson, 1856).

To the west of the Lake, half of the houses of Ma'lun were ruined and 5 people were killed (Waghorn, 1837). At Haifa only three houses were ruined without casualties and at Athlith a few dwellings and one side of the walls were damage. The remains of the church built by the Crusaders collapsed and the rubble was transported to Acre for the construction of the fortifications of the town (M6; Waghorn, 1837; Enlart, 1925).

Further to the south damage was less serious. In Bilad Harithiya 15 villages, which are not named in the sources, were ruined and 18 people were killed. In Arraba and Ajja damage was slight, and in Attil only two houses collapsed, while at Qaqun there was little damage and only a portion of the of the citadel collapsed, but in Jaba and in its environs 99 houses collapsed, 151 were damaged and 23 people were killed (M6).

Berqa and other nearby villages also suffered some little damaged without casualties. Tubas was severely damaged and east of the Jordan river at Ajlun and Jerash there was also some small damage. During the earthquake free-standing columns in the ancient cite of Jerash were seen chattering on their bases but they did not collapse (M6; Lindsay, 1839; Johns, 1932).

In Nablus one quarter of the houses and a number of shops were ruined and one quarter were damaged causing the loss of 48 lives; the rest of the town suffered only light damage. In the district of Nablus 150 people lost their lives (P3; M1; M6; Thomson, 1837; Neman, 1971; Shkelov, 1837).

Damage decreased rapidly to the south; Qaryat Jit suffered very little and at Zeita only one house was thrown down killing 2 people (P1; M6).

Further away to the north, the shock was felt all along the coast, and at Tripoli it caused considerable concern but no damage, fig. 1. At Latakia it was less strong in the town but rather violent in outlying districts. In Antioch ground movements were slow and lasted intermittently for a long time. In Aleppo the shock was generally felt and caused no damage anywhere in the region, while at Kilis it was slight and at Aintab almost imperceptible (M1; M2; M6; P4).

However, in the alluvial plain of Adana the earthquake was strong and caused some panic; many shops in the suq Adanat al-kubra collapsed. Also in the ports of Ayas (or Payas) and Iskenderun there was some alarm among European ship crews on land who became nauseous. The shock was also reported from Tarsus where it was slight but widely felt (M6).

In the east, in Damascus about 2000 houses were slightly damaged, four minarets and several houses were destroyed and about 10 people were killed or injured. The bazaars of the city were damaged and part of the city gates as well as the tops of several minarets, which are not named, were thrown down (M1; M2).

In the south, at the port of Jaffa the shock threw merchandise from stacks and in Ramla it was slow; it was said that people could not stand erect. However, there is no evidence that it caused any damage (M1; M6). In Jerusalem the earthquake was not very strong but it did some small damage. It is alleged that the minarets of

the mosque at Kafr al-Tur, east of the city, were shaken down by the shock (M1; M2; M6; P4, Calman, 1837; Neman, 1971). In the Moab the shock caused sporadic damage, particularly to old sites such as at Dihban where a number of free-standing columns and arches were overthrown (Tristram, 1874). Some slight damage was reported from Hebron, but details are lacking (Neman, 1971). In Gaza the shock was rather slight and except for the customs house which was badly cracked there was no other damage (M6). The earthquake was reported felt from as far south as Mt Sinai (St. Catherines' ?) (Thomson, 1837).

In the south-west the earthquake was felt in the Nile Delta, at Damietta causing water to slosh out of a container and in Misr (Egypt or Cairo?), but it was not reported from Alexandria (Thomson, 1837). In the west the earthquake was rather strong in the ports of Famagusta and Larnaca and was generally felt in other parts of Cyprus (M1).

There is no evidence of a seismic sea-wave on the Mediterranean coast. Also no waves have been reported in the Dead Sea. Allegedly, after the earthquake large masses of bitumen were seen floating in the Dead Sea (Robinson, 1856). It is said that waves flooded the coast of Lake Tiberias but it is not clear whether this happened before, during or after the earthquake (Shkelov, 1837; Kerhardene, 1859).

Aftershocks

Aftershocks continued to be felt for almost four months, three of which are particularly important (M2).

The aftershock of 16 January was widely felt at the southern extremity of the epicentral region and caused considerable damage in the districts of Jaffa and Nablus but details are lacking. This is an important shock of the seismic sequence because if the damages caused by this event were serious and they have been amalgamated in the official damage returns for the earthquake of 1 January 1837, the epicentral area of the main shock should not be extended as far south as Nablus. However, there is no way of telling whether this is so since all of our detailed damage returns are dated February and March 1837 (P2).

The aftershocks of 22 and 25 January which were reported from the north part of the epicentral region caused panic in Damascus but is not known whether they did any damage (M2).

The third aftershock of 20 May was reported from the northern part of the affected area and caused considerable additional damage at Hashbeya, details of which are not known. The shock was strongly felt in the region of Lake Hule but it was not reported felt at Damascus perhaps because of a severe thunderstorm at the time (M2).

Losses

The loss of life caused by this earthquake and its aftershocks is difficult to estimate. The reported figure is 6-7000 killed but this is an early official estimate given by (M2) that probably does not include losses in the districts of Marjuyum, al-Touffa and Banyas where many places within a radius of 50 miles (80 km) of Banyas were seriously affected, and about which we have no information (M2).

A plague epidemic shortly after the earthquake added to the loss of life and isolated the coastal area from the hinterland, a situation aggravated by the Bedouins who for some time after the earthquake kept on hovering about ruined villages and towns. Safet, Tiberias and villages in the region of Bshara were plundered repeatedly by roving Druses and Mtwalis (M1; M4; Montefiori, 1844).

The combined effects of the earthquake, plague and unrest had considerable social implications: because of a rise in the price of labour, before long merchants began to find it difficult to transact their business (Rustum, 1923) and commerce was paralysed for a number of years.