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Erroneous interpretation of historical documents related to the epicenter of the 1927 Jericho earthquake in the Holy Land

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Abstract

The 1927 earthquake was the strongest seismic event (M = 6.2) of the 20th century in the Holy Land and the first significant one in the region to be recorded worldwide by seismometers. By quoting the seismological station in Ksara, the ISS located the epicenter 40 km north of the Dead Sea. This location, which was supported by secondary and tertiary macroseismic 'evidence' and became one of the most accepted 'facts', was never questioned nor reevaluated. We show how an initial mistaken earthquake location, supported by questionable evidence, struck roots and eventually became an accepted fact. This typical 'chain of errors' may serve as a warning regarding treatment of historical macroseismic sources, as well as historical microseismic documents. The conclusions drawn from this study, while focusing on historical documentation, fit well the new epicenter of the 1927 earthquake, recalculated in our former study.

Abbreviations: ISS – International Seismological Summary

Introduction and methodology

The epicenter and the magnitude of earthquakes are essential data for seismic hazards assessments. Therefore, attempts have lately been made in the study of historical earthquakes to evaluate these parameters, based on all data available from archives (Albini et al., 1991; Ambraseys, 1997, 1997a; Ambraseys and Melville, 1987; Ambraseys and Barazangi, 1989; Justo and Salwa, 1998; Munoz and Udias, 1987; Piastanesi and Tinti, 1998; Toppozada and Borchardt, 1998 and many others). For this purpose, only original material should be used. When only second-hand material is available, this should be properly indicated, as suggested by Ambraseys et al. (1983), Ambraseys (1997), Postpischl et al. (1991), Tiedemann (1992), Guidoboni (1994), and Musson (1996). Moreover, all raw material and documents processed should be presented without being subjected to undue rationalization to accommodate private theories. It is important that the raw data is made available, so that later researchers can add or reinterpret it in different ways (Ambraseys et al., 1983).

We investigated the Jericho earthquake of July 11, 1927 (Figure 1), by integrating macroseismic and microseismic data, including all available historical sources and testimony (Avni, 1999). Almost all primary historical documents concerning the 1927 earthquake were reviewed at the most important relevant archives in Israel, Great Britain and the U.S. These include the archives of the 'Public Record Office', 'The British Museum', 'The School of African and Asian Studies' at the University of London, 'St. Anthony's College' at Oxford University, Princeton University, the official archive of the State of Israel and the archives of the city of Jerusalem and the city of Nablus. All this macroseismic material was sorted and preserved as a computerized textual database, according to geographical and subject keys. We evaluated the data obtained with particular attention to the

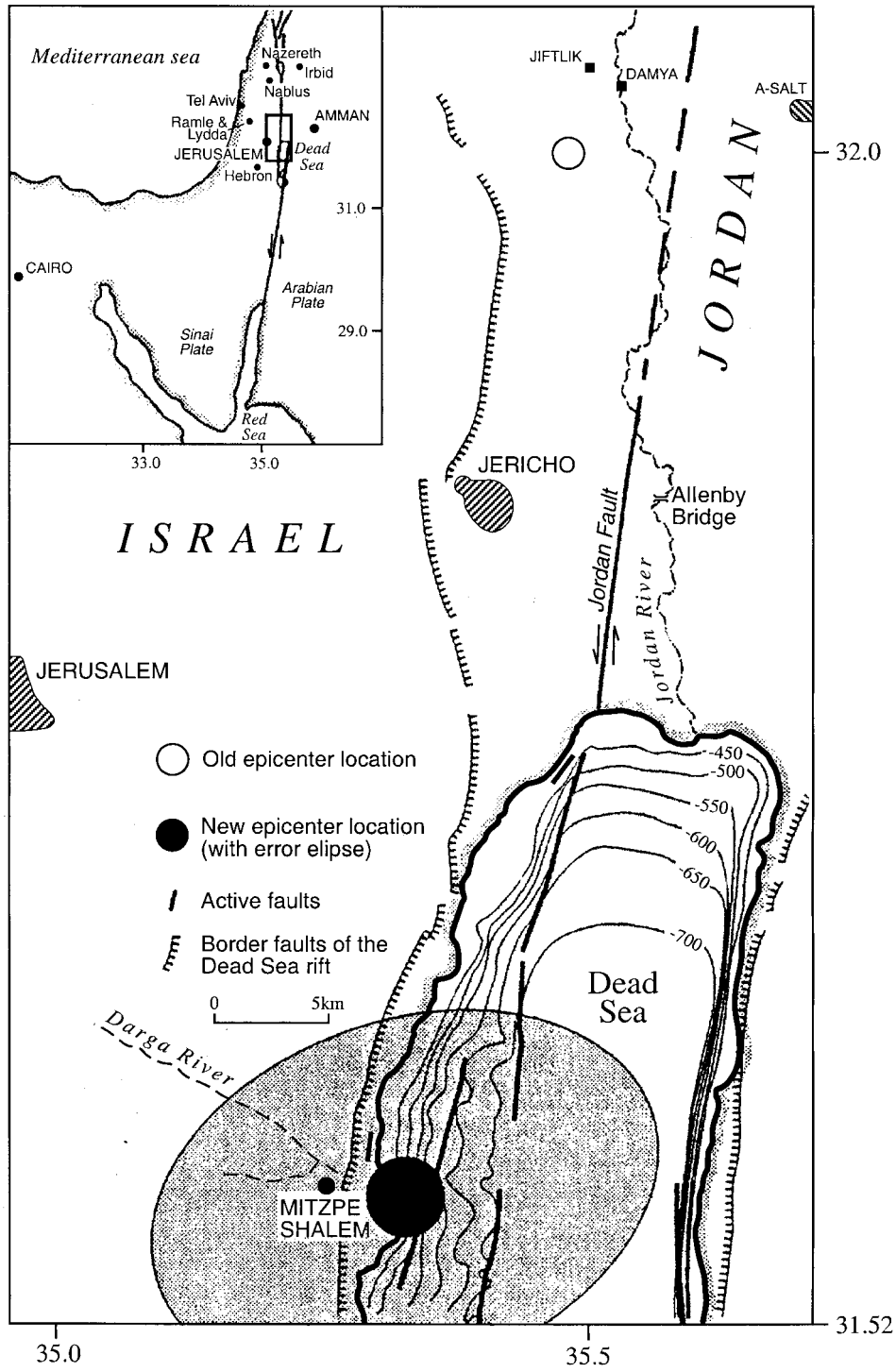


Figure 1. Location map (after Niemi and Ben-Avraham, 1994) with the epicentral area of the 1927 earthquake.

quality of the sources: We regarded the documents of the 'Public Work Department' of the British Mandate as of high reliability, as they were written by experts using professional descriptions. Reports of public organizations, like municipalities, who were interested in financial support, were treated with caution. However, those documents were accepted when supported by other primary sources. Following Poirier and Taher (1980), we totally ignored the documents of the Jewish community in Jerusalem, which were rich with superlatives and cliché, useless for evaluation of seismic intensity. Following this procedure 133 settlements and sites were left for assessment of the seismic intensity by the MSK scale, and a detailed intensity distribution map was drawn (Figure 2).

The Jericho 1927 earthquake

On the 11 of July, 1927, at 15:04, a destructive earthquake startled the residents of the Holy Land. Its magnitude was M_L = 6.2 (Shapira, 1979; Ben-Menahem et al., 1976). The epicenter was estimated to be in the Jordan Valley, in the vicinity of the present Damya Bridge (coordinate 32.0°N–35.5°E – Ben-Menahem et al., 1976; I.S.S., 1927; Figure 1).

The effects of the quake were severe, particularly around Nablus, Ramleh, Lydda, Jerusalem and Jericho. A total of 60 people were killed and about 500 were injured in Nablus. In Ramleh and Lydda, 50 people were killed and about 160 were injured. Almost all the religious quarters of Jerusalem sustained heavy damage, but without many casualties: few people were killed and less than a few dozen were injured. The area of Mount of Olives and Mount Scopus suffered, in particular the Government House in Augusta Victoria, the buildings of the Hebrew University and also churches in the old city. In most of the villages around Jerusalem houses were destroyed, causing casualties and injuries. In Jericho many houses and buildings were ruined, among them a two-story high hotel that collapsed, causing the death of 3 occupants. Far from the epicenter, villages near Nazareth and Hebron also suffered destruction and casualties. A large part of A-Salt, in Trans-Jordan, was ruined, with 32 casualties and dozens wounded. Amman suffered severe damages, although less than A-Salt, and together 11 residents were killed. In Irbid, north Trans-Jordan, 15 People were killed. Landslides and slumps occurred along the Jordan River, between the Allenby-Bridge and the Dead Sea and a *seiche* of about one meter was formed in the Dead Sea. Various effects of less severe destruction, generally typified by cracks in walls or plaster occurred in the Galilee, in the Coastal Plain, in Tel-Aviv and in various places. The quake was recorded in more than 100 stations worldwide. All together 285 people were killed and about 1,000 injured.

The doubt regarding the putative epicenter

Until our investigation, it was accepted that the epicenter of the 1927 earthquake was at 32.0°N–35.5°E (Figure 1). This location, was first mentioned in the scientific literature in the annual bulletin of the ISS from 1927, that is quoting the seismographic station KSR of Ksara in Lebanon. We assume that their location was based on polarity analysis of the P waves arriving to KSR, and mainly on the news reports that elaborated on the damage and casualties in Nablus. The first critical analysis of the epicentral localization was made by Ben-Menahem et al. (1976). They used four seismograms, and adopted the location determined at Ksara, apropos correcting the origin time from 13:03:55 to 13:04:07 (GMT). As 'verification' of the epicenter location in the area of Damya, Ben-Menahem et al. (1976) adopted the descriptions made by Brawer (1928) of cracking and slumping phenomena between the northern Dead Sea and the Allenby Bridge. However, these descriptions can fit an epicenter at any point in between these two places. Observations of such phenomena north of the Allenby Bridge might have supported the conclusions of Ben-Menahem et al. (1976); however, Brawer (1928) does not include a single description of this area supposedly because damage there was not significant.

Additional doubts regarding the 1927 epicenter determination are related to the testimony of Braslavski (1938) about the collapse of the banks of Jordan River close to Damya, damming thereby the Jordan for twenty-one hours. The damming of the Jordan near Damya became a crucial evidence for locating the epicenter near Damya by Ben-Menahem et al. (1976). However, upon close examination of Braslavski's text, it becomes clear that he relied entirely on Garstang (1931), a study that tried to relate natural disasters to miraculous biblical events. Garstang (1931) is the only source reporting about the Jordan's damming at Damya and it is important to examine the context in which Garstang indicates the event. Namely, his aim to prove that Damya is the biblical 'city of Adam', where the Israelites crossed the Jordan under the leadership

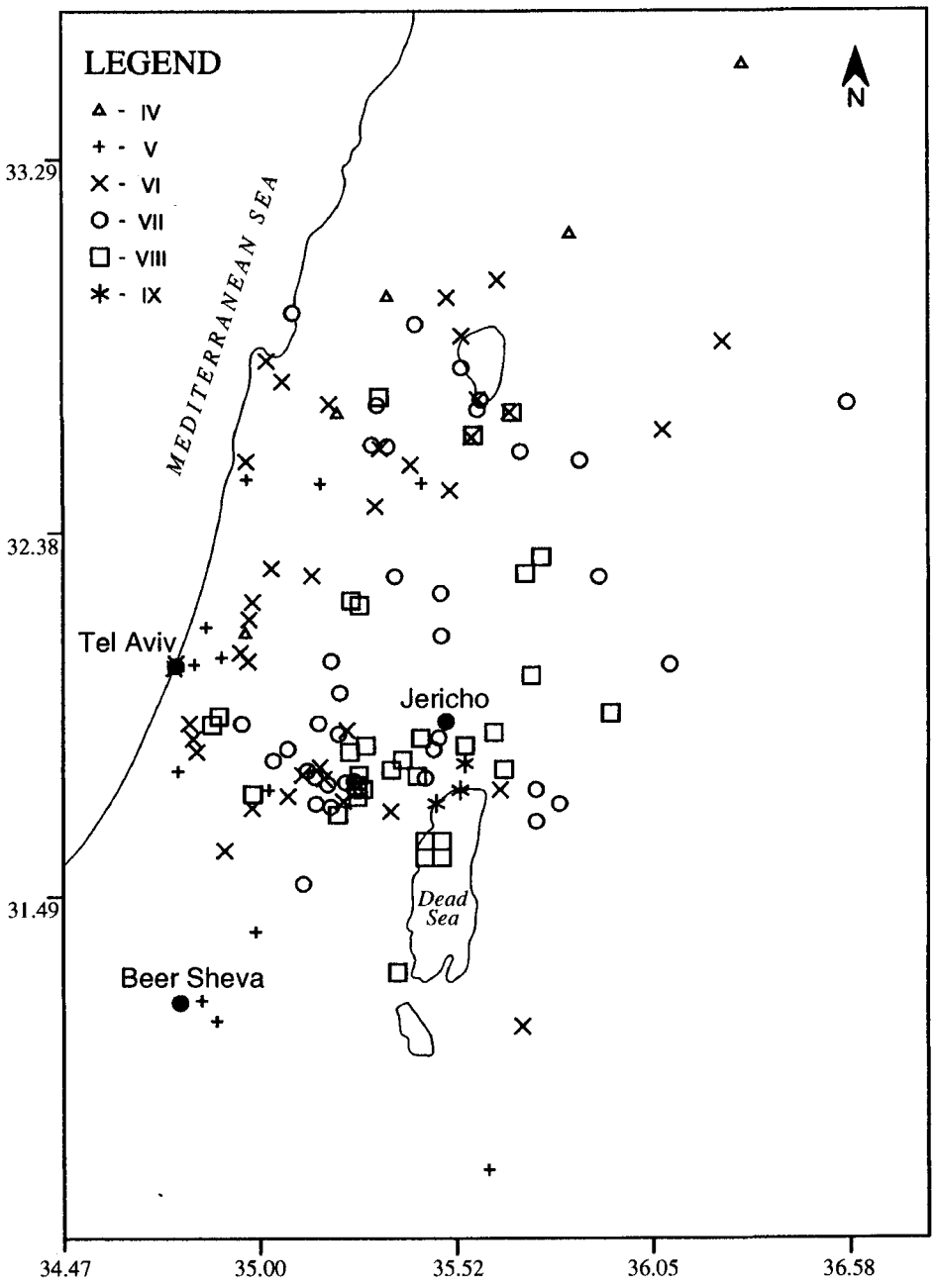


Figure 2. A detailed intensity distribution map of the 1927 earthquake.

of Joshua Ben-Nun. Thus, he provides a 'scientific' explanation i.e., the occurrence of an earthquake that enabled the crossing a flowing river without a bridge (Garstang, 1931). Garstang cites 'the event of the damming of the Jordan River' as an empirical evidence related to the 1927 earthquake. He recruits also the verse from 'The Song of Deborah' that connects, in his words, 'the Exodus of the Israelites from Edom with an earthquake'. It should be mentioned that modern biblical research relates this verse to the revelation at Sinai, and not to the crossing of the Jordan River (Hartom and Kasuto, 1988).

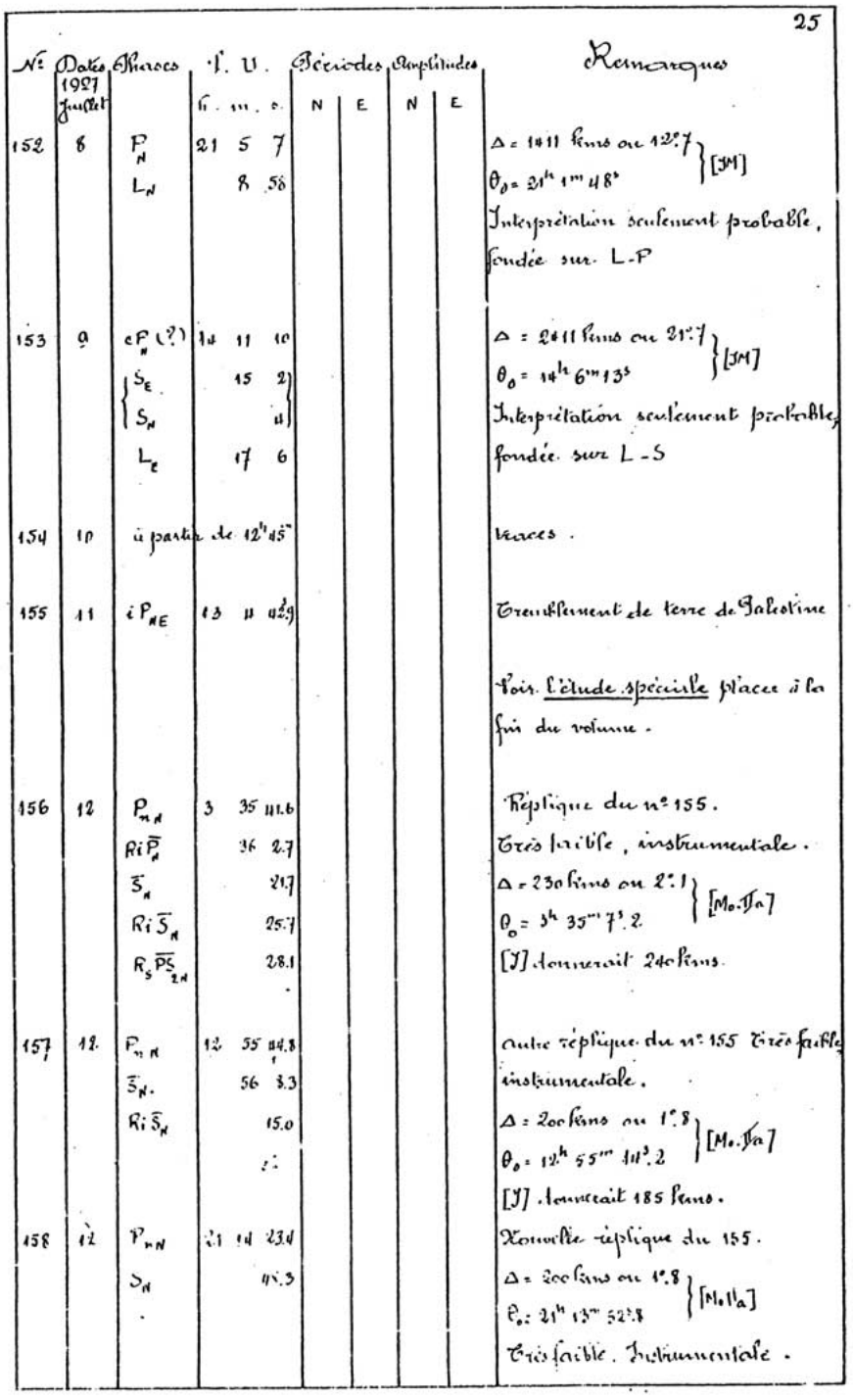
The descriptions of the river bank collapses by Garstang (1931) are reminiscent of the descriptions of the collapses of the Jordan banks at the St. John monastery and at the adjacent baptism site near Jericho by Abel (1927), Blanckenhorn (1927), Sieberg (1932), and Brawer (1928). Two researchers – Abel and Brawer – were in Palestine during the earthquake. Abel was in the northern Dead Sea area, by the Jordan outlet and in the Jericho area. Garstang himself was not in Palestine during the earthquake at all. At that time he had finished his term as headmaster of the British School for Archeology in Jerusalem and at the Department of Antiquities of the British Mandate Government, and had already returned to England. He returned to Palestine only later. In his manuscript, he testifies that he got at least part of the information about the earthquake from the manager of the Antiquities Department of Trans-Jordan. Therefore, his descriptions of the collapses along the banks of Jordan River seem be an unsuccessful copy of descriptions he had found elsewhere. He cannot be regarded as an eyewitness, only a secondary source, and this is what makes the difference.

Perhaps more significant than Garstang's testimony, is the absence of any evidence supporting him. None of the documents we examined mention damming of the Jordan River: not the documents of the British Mandate Government and the British Police, not the press releases on the earthquake, not Brawer (1928), Abel (1927), Willis (1928) and not even one of the German researchers who studied the earthquake in the Holy Land (Blanckenhorn, 1927; Sieberg, 1932). If damming of the Jordan River occurred, it is reasonable to expect that the police or other sources would report on it. This conclusion is based on two facts: A. When the road between Amman and the Allenby Bridge in Wadi-Shueb was destroyed during the earthquake, the police reported it (as Garstang reports that the road in Damya became 'disconnected' during the earthquake as a result of the collapse). B. There was a police station in Jiftlik adjacent to Damya, and it is reasonable to assume that such a dramatic event would be known to them.

Besides its general unreliability, there are additional methodological grounds for rejecting Garstang's testimony: Garstang has an 'interest' in adopting the story of damming the Jordan River in Damya: by calling on the earthquake-triggered bank collapse, he gets a scientific explanation for his thesis of crossing the Jordan River by the Israelites, at Damya toward Jericho. However, we adopt the accepted methodological rule in historical research, which states that a source with an 'interest' should not be accepted as evidence, particularly if it is without any support. Therefore damming of the Jordan River during the earthquake of 1927 in Damya cannot be regarded as reliable.

Studying the macroseismic evidence and the ISS bulletin, it seemed evident that the location near Damya was never examined, nor determined from instrumental data, i.e. arrival time measurements. Consequently, we already have recalculated the 1927 earthquake epicenter, using available readings of P waves to seismograph stations (ISS, 1927). A detailed analysis of those data has been presented by Shapira et al. (1993). In brief: we used data of stations that reported arrival time up to a distance of 40° from the previously published location. We applied the robust search on grid procedure to obtain a solution with the least RMS values of the time discrepancy to the stations, using IASPEI 91 travel time model. The new location of the epicenter was calculated as 31.6°N – 35.4°E as shown in Figure 1. As indicated by many researches (see also Shapira and Du Plessis, 1989; Palvis, 1986) standard error ellipse computations are irrelevant to this particular case, and the uncertainty is estimated by presenting different solutions provided by different combinations of the available readings. The new location is about 50 kilometers south of the previous one, in the northern Dead Sea (Figure 1). As suggested by Shapira et al. (1993), it is probably the first location determination of the 1927 earthquake that is based on instrumental data.

Close examination of the bulletin of the Ksara station (Berloty, 1927) from the day of the main shock, shows that the arrival time of the S waves was not measured (Figure 3), probably due to the saturation of the seismogram. Thus, the time interval S-P could not be used to estimate the distance to the epicenter. The analysis of the three-component P wave, may have



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N°	Dates 1927 juillet	Phases	T. U. h. m. s.	Périodes N	Périodes E	Amplitudes N	Amplitudes E	Remarques
152	8	P_N	21 5 7					Δ = 1811 kms ou 12°.7 [JM]
		L_N	8 58					θ_0 = 21h 1m 48s
								Interprétation seulement probable, fondée sur L-P
153	9	eP (?)	14 11 10					Δ = 2411 kms ou 21°.7 [JM]
		S_E	15 2					θ_0 = 14h 6m 13s
		S_N	4					Interprétation seulement probable,
		L_E	17 6					fondée sur L-S
154	10	à partir de 12h 45m						traces.
155	11	i P_{NE}	13 11 42.9					Tremblement de terre de Palestine
								Voir l'étude spéciale placée à la fin du volume.
156	12	P_{nN}	3 35 11.6					Réplique du n° 155.
		Ri $\overline{P}_N$	36 2.7					Très faible, instrumentale.
		$\overline{S}_N$	21.7					Δ = 230 kms ou 2°.1 [Mo.Ja]
		Ri $\overline{S}_N$	25.7					θ_0 = 3h 35m 7s.2
		$R_S \overline{PS}_{2N}$	28.1					[J] donnerait 240 kms.
157	12	P_{nN}	12 55 44.8					Autre réplique du n° 155 très faible,
		$\overline{S}_N$	56 3.3					instrumentale.
		Ri $\overline{S}_N$	15.0					Δ = 200 kms ou 1°.8 [Mo.Ja]
								θ_0 = 12h 55m 44s.2
								[J] donnerait 185 kms.
158	12	P_{nN}	21 14 23.4					Nouvelle réplique du 155.
		S_N	48.3					Δ = 200 kms ou 1°.8 [Mo.Ja]
								θ_0 = 21h 13m 52s.8
								Très faible. Instrumentale.

Figure 3. The page from the bulletin of the Ksara station, which recorded the 1927 earthquake (event no. 155).

been used to determine the azimuth from KSR, but that azimuth fits both the discussed above locations. The new origin time is 13:04:06.2, almost identical to the time calculated by Ben-Menahem et al. (1976).

Complementary evidence

It is accepted worldwide that the area with the most severe seismic intensities is not necessarily where the epicenter is located. Nevertheless the new location is in agreement with the macroseismic evidences. The detailed analysis of the 1927 earthquake by Avni (1999), shows that MSK intensity data are more consistent with the new solution rather than with an epicenter near Damya bridge: Cracks formed on the beach in the northern Dead Sea, very similar to those formed during the earthquake of the 22 of November 1995 in the Ras Mamlach beach in Sinai, which is adjacent to that earthquake epicenter (Bigger and Shiler 1988; Wust, 1997). A one-meter high 'Seiche' was reported in the northern basin of the Dead Sea, and along the Jordan River up to the Allenby Bridge the banks collapsed (Brawer, 1928; Abel, 1927).

A bathymetric slump was identified in the northern Dead Sea, and has been related to the *seiche* formed by the 1927 earthquake (Niemi and Ben Avraham, 1994). Liquefaction in the fan delta of the Darga River adjacent to the new epicentral area, has also been ascribed to the earthquake of 1927, based on its ^{14}C age (Kadan, 1997). The evidence of liquifaction would not support an epicenter near Damya which is 50 km northwards, taking into account its relative low magnitude of ML = 6.2. The new location may mean that the earthquake of the 11 of July 1927 activated a southern segment in the rift valley, not the northern one as suggested before (Rotstein, 1987; Shapira, 1988; Ben-Menahem et al., 1976).

Conclusions

The importance of screening procedures of sources reporting about historical earthquakes is presented, leading to the following main methodological conclusions:

- The significant difference between primary, secondary and tertiary sources has been demonstrated. Secondary and tertiary sources are shown to contribute towards confirmation of mistakes.
- Uncritical acceptance of descriptions, ignoring their secondary or tertiary status, may lead to erroneous conclusions.
- Examining supporting evidence of doubtful events is further shown as a very efficient tool.
- The objectivity of historical sources is shown as an important criterion, when evaluating validity of documents.

For the past 70 years, geophysical research and catalogs accepted that the 11 of July 1927 earthquake epicenter is located adjacent to the present-day Damya Bridge. Our analysis suggests that this was based on an erroneous determination and assumptions, heavily based on secondary and tertiary controversial historical sources, which were not critically examined. The new determination of the epicenter is in the northern basin of the Dead Sea, opposite Kibbutz Mitspeh-Shalem. This location may relate to a different segment of the Dead Sea Transform, and allows for more reliable earthquake hazard assessments.

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