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Historical evidence of faulting in Eastern Anatolia and Northern Syria

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Abstract
Historical data show that like the North Anatolian fault zone, which was delineated by a series of earthquakes during this century from east to west, so was the conjugate Eastern Anatolian fault zone delineated from the northeast to the southwest by a succession of large earthquakes in earlier times, with a major event at its junction with the Dead Sea fault system. This event was associated with surface faulting and occurred in a region seismically quiescent for nearly two centuries.

Key words *earthquakes – faulting – Anatolia – Syria – historical data*

1. Introduction

Evidence of surface faulting associated with historical earthquakes, though often imprecise, is important for the assessment of the tectonic activity of a region. Such evidence may be used to answer questions such as: does the seismicity of the historical period reveal all the major tectonic structures that are known to be active and, does faulting over a period much longer than the present century correlate with geological structures revealed in the geomorphology, but which so far have not been proven to be active?

In this paper we examine two little-known cases of surface faulting in Eastern Anatolia and Northern Syria.

2. 1254 October 11

This large earthquake in the North Anatolian fault zone occurred on Sunday 11 October 1254. Contemporary and later Armenian sources record the event, which caused destruction in the region between Erzincan and Sivas (Hakobyan, 1956:141; Araqel:30,567), fig. 1. The loss of life was variously estimated between 15000 (Hakobyan, 1956:264) and 56000 (Garegin, 1951:207). The earthquake chiefly affected Erzincan and country areas to the west; no information is available for other towns in the region, which had probably suffered heavily from the Mongol occupation over the previous decade. Although the earthquake was reported by Persian authors (Mustaufi: 588, with the date 652 a.H.), it does not seem to have been experienced as far away as Iran; the shock is not mentioned in contemporary Arabic sources, such as Sibt b.al-Jauzi, Abu Shama and al-Makin.

The effects of the earthquake and of the associated fault break are described by Friar William Rubruck, who was passing through the area in February 1255. He says (Rubruck:271-272):

«... *On the second Sunday in Lent* [21 February 1255] *we reached the headwaters of the Araxes* [Aras river]*; and after crossing the ridge of the mountain we arrived at the Euphrates and*

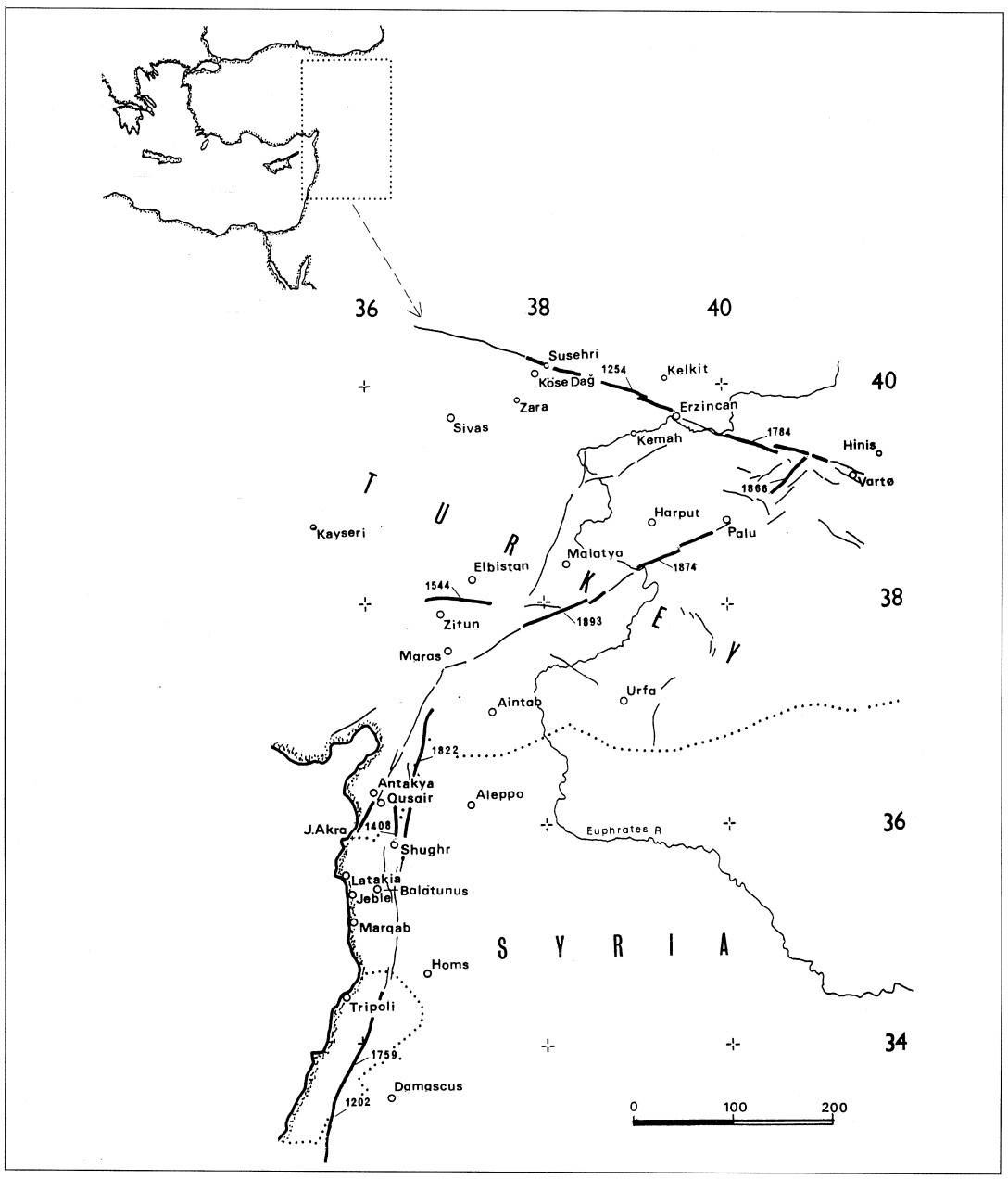

Fig. 1. Location map and inset of the region, showing major towns mentioned in the text as well as active tectonic lineaments (thin lines) from Saroglu *et al.* (1992). Heavy lines show probable locations of surface faulting inferred from historical data. Neither their exact length nor their attitude can be deduced with certainty, and their shape has been drawn to follow known active fault zones. Note that one or other of the fault traces shown on either side of Qusair was activated in the 1408 earthquake; not both.

followed it downstream for eight days, constantly heading west, as far as a fortress called Camath [Kemah]. *Here the Euphrates veers southwards, in the direction of Halapia* [Aleppo], *while we crossed the river and headed west among very high peaks and very heavy snow. That year such a severe earthquake occurred here that in one city, called Arsengen* [Erzincan], *there perished 10000 people identifiable by name, not counting the poor, of whom there was no record. As we rode along for three days we saw a fault in the earth, exactly as it had been split open in the earthquake, and piles of earth that slid down from the mountains and filled the valleys* [...] *We passed through the valley where the sultan of Turkia was defeated by the Tartars... In the plain where this fight* [...] *occurred, a great lake had welled up in the course of the earthquake ...».*

From his itinerary it appears that Rubruck followed the high road which went from Hinis, south of the Araxes, to Kemah where he crossed the Euphrates, passing to the south of Erzincan. From there, because of the time of the year, after crossing the Euphrates, he followed the Byzantine route via Satala and Susehri to Kose Dag, and from there via Zara to Sivas. He does not mention Kose Dag by name; but the battlefield where the Turks were routed by the Mongols, on 26 June 1243, is in the valley at the end of the Kose Dag defile, near the sources of the Yesil Irmak.

After its crossing with the Araxes at Kemah, and for a distance of three days' journey, Rubruck's route followed the North Anatolian fault zone for about 50 km. The ground features he describes imply extensive surface faulting, which he distinguishes from those due to the landslides triggered by the shock. The lake to which he refers in the vicinity of Kose Dag was probably a sag-pond or a lake formed by a landslide which dammed the river.

It is possible that surface faulting extended to the east as far as Erzincan, a region totally destroyed by the shock, in which case the fault break would have been 150 km long, associated with large displacements. There is a disparity between the 50 km actually seen by Rubruck and the 150 km we propose. The fact that Erzincan was destroyed is, we think, sufficient to justify this.

3. 1408 December 29

The earthquake of 29 December 1408 in Northern Syria is not correctly identified in any of the regional or global catalogues, and is generally ignored (one exception being Poirier and Taher, 1980:2193). It was preceded by five years of intense seismic activity and caused extensive damage in the Orontes valley, south of Antakya, fig. 1.

The first shock in the series occurred around noon on Friday 3 Jumada II, 806 (18 December 1403, a Tuesday). It was felt in Aleppo and its dependencies, but caused no damage (Ibn Hajar:ii,262; Atsiz, 1961:19).

A more damaging earthquake took place two months later, on 8 Sha'ban 806 (20 February 1404), affecting the region west of Aleppo, where many places were destroyed (Ibn Hajar:ii,262; Ibn al-Shihna:fol. 131a). Both these sources mention that it was followed by a long sequence of aftershocks which caused considerable concern, particularly to the west of Aleppo, for the remainder of the Muslim year 806. Other accounts mention that the worst effects were experienced in the district of Tripoli, where many buildings were destroyed (al-Jauhari:ii,186). Either as a result of this shock, or of further strong aftershocks, part of the castle of Marqab collapsed at the beginning of Ramadan (mid March), together with other structures elsewhere (al-Jauhari:ii,186; al-Maqrizi:iii,1122).

The third distinct event in the series happened in Aleppo at midday on 3 Jumada I, 807 (7 November 1404). The shock was of long duration and was widely felt in other towns of the region. The earthquake caused great alarm, and was followed by a few aftershocks, but no damage was reported (Ibn Hajar:ii,269, 290, 296; al-Suyuti:56).

The fourth shock took place about two years later in Dhu'l-Qa'da 809 (April 1407). In Antakya (Antioch) 100 people or more were killed, but there is no evidence that the earthquake caused damage elsewhere (Ibn Hajar: ii,355; al-Suyuti:56). An earthquake felt strongly throughout Cyprus on 29 April 1407 may be the same event, though the correct year of this contemporary marginal note is dif-

ficult to decipher (Christophides, 1969:325; Darrouzes, 1951:43).

This series of shocks culminated in a large earthquake in the region on 10 Sha'ban 811 (29 December 1408).

The earliest source to mention the event is a Turkish taqvim (calendar) of Persian origin composed in 824 a.H. (1421) which says that *«... It is 14 years since there was a great earthquake in Shughr and Antakya [Antioch]; Shughr and its region were destroyed ...»* (Atsiz, 1961). Two other taqvimler, composed in 849 a.H. (1445) and 850 a.H. (1446), repeat this information, saying that it was respectively 38 and 39 years since the district and fortress of Shughr and some places in Antioch were destroyed by a terrible earthquake (Turan, 1954:14-15, 46-47). These sources clearly refer to a single event, to be identified as the earthquake of 811 a.H. (1408). The silence of the later takvimler about the earlier shocks suggests the relative gravity of this earthquake and indicates that it was the most important event in the series.

The exact date and further details are given by Ibn Hajar (ii,400-401), whose account of the earthquake is as follows:

«On 10 Sha'ban 811 [29 December 1408] *a great earthquake affected the districts belonging to Aleppo and Tripoli, and destroyed a number of places in Latakia, Jabala* [Jeble] *and Balatunus* [a stronghold opposite Latakia called Mansio Platanus by the Crusaders]. *The castle of Balatunus collapsed and 15 people were killed; 15 people were also killed in Jeble. Shughr Bakas was totally destroyed with its castle, and all but 50 of its inhabitants were killed. The ground fissured and was thrown down over the distance of a stage, from the town of Qusair to Saltuham (?) – a town on top of a mountain – about a mile of which moved during the night, carrying with it trees, buildings and their inhabitants, who were unaware of what was happening. The shock also affected Cyprus, where many places were destroyed in the mountains and the plains* [lit: *«watering places»*]. *Snow was seen on the top of Jabal Aqra'* [Jebel Akra 1759 metres], *and the sea receded for 10 farsakhs* [*c.* 60 km] *and then returned. Ships at sea touched the bottom before the water returned to normal, without hurting anyone».*

This report, and a variant version given by al-Maqrizi (iv,80-81), is the basis for all subsequent accounts of the earthquake, and is not without difficulties, not least due to the spelling and identification of some of the more obscure places mentioned. Furthermore, there is some confusion in the chronicle of al-Maqrizi, who reports several of the details of this event twice: once together with his account of the earthquake of Sha'ban 806 (iii, 1122) [see above], and again under Sha'ban 811 (iv,80-81). This has misled later authors, such as Sibt b. al-'Ajami, who date the earthquake Thursday 10 Sha'ban 806 (22 February 1404, a Friday), followed by other historians of Aleppo.

Of particular interest is the account of faulting. A stage (barid) is theoretically around 20 km, but varies according to the nature of the ground and the conversion formulae used (Sauvaget, 1941:27-28). The north end of the rupture should be south of Antioch in the vicinity of modern Qal'at al-Zau, where the castle of Qusair was located (Dussaud, 1927:429). The location of Saltuham – variously also written as Salquham (Ibn Hajar, ed. Hyderabad, vi,100) or Salfuham (al-Maqrizi: iv,80), or possibly Shalghuhama (Katib Celebi, *cit.* Charmoy, 1868:270) – is not known, but it should probably be sought about 20 km to the south of Qusair, in the region of Shughr Bakas (see below). As in the account of the earthquake of 1254, a distinction is made between the faulting and a landslide, evidently triggered by the shock. The story that Saltuham was transported bodily down the mountain while its inhabitants slept is similar to many others found in the Arabic chronicles and is something of a literary topos. Although the superficial resemblance is non-existent in Arabic script, it is conceivable that S(h)alfuham should be equated with Kashfahan (Hisn Tell Kashfahan), near Jisr al-Shughr on the Orontes, an association seemingly implied, but not developed, by Blochet (1902:39 n. 1) and Dussaud (1927:159 n. 2).

That this was the area worst affected is suggested by the damage to Shughr, located about 7 km northwest of Jisr al-Shughr, on the borders between the provinces of Aleppo and

Tripoli. It is a double castle, consisting of two fortresses on either side of a saddle-back which lies in the centre of a very narrow ridge; this has steep slopes on every side, except where it is isolated from the main mountain by a wide and deep fosse. The twin fortresses, Bakas to the south, Shughr to the north, are separated by a level stretch of ground fringed by two small fosses. To the north and east the castle looks over the Nahr al-Abyad, and westwards towards a valley leading to the village of Shughr al-Qadim (Berchem, 1914:259, 264; Dussaud, 1927:156-160).

Although the damage to Shughr and Bakas makes it likely that the fault extended in this direction, another possibility must be considered. As it stands, Ibn Hajar's reference to snow on the top of Jebel Akra is irrelevant (it was mid-winter). But by incorporating the information into his account of the earthquake, he implies that this area too was affected. The wording of al-Maqrizi's text is that (part of) the mountain fell into the sea, and it was this that caused the retreat of the sea 10 farsakhs from the mountain. The extension of the earthquake destruction into Cyprus also emphasises the southwesterly trend of damage, and is consistent with reported effects in Latakia and Jeble on the coast. The tsunami could be associated with faulting extending offshore, or with submarine slumping. This interpretation would then require «Saltuham», the scene of the landslide and supposed end of the fault-break, to be located in the Jebel Akra area, which is perfectly plausible.

It is worth noticing, in passing, that the tsunami reported along the Lebanese coast, associated with a destructive earthquake in Syria in 1402 or 1403 November 16 (*e.g.* Ben-Menahem, 1979:287), which at first sight might be connected with the events of 1408, in fact occurred in the Gulf of Corinth. The mistake seems to have been introduced by Perrey (1850:20), whose source clearly states that Greece (not Syria) was the area worst affected [Jacobus de Delayto, in Muratori (1731:974)]. The location of the earthquake and tsunami in the Gulf of Corinth is confirmed by contemporary documents from Venice (Thiriet, 1975:5-7).

Although the exact location of the 1408 fault-break cannot be identified today, the available evidence suggests that surface faulting extended for a distance of at least 20 km from Qusair, either southwest in the direction of the coast, or south along one or more strands of the Dead Sea fault system which run discontinuously along the west flank of the Orontes river towards Jisr al-Shughr. This part of the system has been quiescent for more than 200 years.

4. Discussion

Despite shortcomings in the documentary evidence for early earthquakes, information about surface faulting is sometimes found in contemporary accounts of historical events. In some cases one can determine from explicit information whether these features were primary and of tectonic origin or secondary and due to landslides, liquefaction or slumping of the ground. Ground deformations due to surface faulting may be identified in the sources from their description as ground ruptures caused by the earthquake that extended continuously or discontinuously along considerable distances of tens of kilometres. The length of these ruptures is rarely given precisely but in some cases it can be assessed from the distances between the localities which they traversed or from the dimensions and shape of the epicentral region. However, these cases are relatively few and hard to verify, particularly when their origin is secondary and their effects widespread. To a lesser extent this is so even for modern cases of deformations due to large scale landsliding and slumping of the ground, which are sometimes misinterpreted as surface faulting and *vice versa.*

For large earthquakes, evidence of faulting may be inferred from the association of narrow and very long epicentral regions with a known active fault zone. In such a case historical information will not reveal the exact location of an active structure, but it will help to define the part of the zone that was activated.

Apart from the two cases described above, we may indentify other sites in this region that

Table I. Faulting in Eastern Anatolia and Northern Syria identified from historical sources.

Date	L	Q	Source
1202 May 20	200c	C	Ambraseys and Melville (1988)
1254 Oct. 11	150c	A	This study
1408 Dec. 29	20+	A	This study
1544 Apr. 22		C	Ambraseys (1994)
1759 Nov. 25	100c	A	Ambraseys and Barazangi (1989)
1784 July 18		B	Ambraseys and Finkel (1995)
1822 Aug. 13		B	Ambraseys (1989)
1866 May 12		A	Ambraseys (1994)
1874 May 3		A	Ambraseys (1989)
1893 Mar. 2		B	Ambraseys (1989)

L = estimated length of fault break (km). For quality Q, see text.

were probably associated with historical faulting. These cases, which are shown in fig. 1 and are listed in table I, fall into three categories Q:

A) surface faulting explicity described in the sources;

B) for large events, faulting inferred from the elongated shape of their epicentral region which extends along a known active fault;

C) faulting assumed because of the large size of the event and its proximuty to a known active fault zone.

Their location is shown in fig. 1, from which it can be seen that most of them are associated with well-known major fault zones. However, in almost none of these cases do documentary sources provide more than some slight evidence for their existence. Neither their exact length nor their attitude can be deduced with certainty, and their shape in fig. 1 has been drawn to follow known major active lineaments. Nevertheless, historical information can provide some clues for locating and dating these features, using trenching techniques and GPS measurements, see for instance Ambraseys and Jackson (1990).

The value of the information shown in fig. 1 lies not so much in the similarities but rather in the differences beween the tectonic pattern of the region and the location of the historical cases of faulting. Several cases, in 1408, 1544 and 1822, fall outside the known pattern. It is also of interest that like the North Anatolian fault zone, which was delineated by a series of earthquakes during this century from east to west, so was the conjugate Eastern Anatolian fault delineated from Varto in the northeast to Maras in the southwest by a succession of large earthquakes during the last century.

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