

The Kashmar (Turshiz) 1903 and Torbat-e Heidariyeh (South) 1923 earthquakes in Central Khorassan (Iran)

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SUMMARY. — New bibliographical and field data are presented on two little-known earthquakes which occurred in the Khorassan Province of Iran. The Kashmar (Turshiz) earthquake of 25 September 1903 destroyed part of the present-day town of Kashmar and some surrounding villages and killed 209 people. The Torbat-e Heidariyeh earthquake of 25 May 1923 destroyed completely 5 villages south of Torbat-e Heidariyeh and killed 2,219 people. Both these earthquakes and a few other smaller ones after 1900 present the characteristics of being located on or near the active Doruneh Fault, of having moderate magnitudes between 5 and 6, of being very shallow and responsible for high intensities restricted to areas less than 10 km in maximum dimension.

RIASSUNTO. — In questa nota sono riportati nuovi dati raccolti bibliograficamente e in loco concernenti due terremoti poco conosciuti, avvenuti nella Provincia di Khorassan (Iran). Il terremoto di Kashmar (Turshiz) del 25 Settembre 1903 distrusse parte della attuale città di Kashmar e alcuni villaggi circostanti causando la morte di 209 persone. Il terremoto di Torbat-e Heidariyeh del 25 Maggio 1923 distrusse completamente cinque villaggi a sud della città provocando la morte di 2.219 persone. Entrambi i terremoti ed alcuni altri d'intensità minore dopo il 1900, presentano le seguenti caratteristiche: sono localizzati sulla o vicino alla faglia attiva di Doruneh; hanno una magnitudo moderata compresa fra 5 e 6; sono molto superficiali e di elevata intensità; mentre l'area macrosismica interessata è, nella sua massima dimensione, inferiore ai 10 km.

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1. - INTRODUCTION

1.1 *General*

Very little precise information has been uncovered to date on the many destructive earthquakes known to have occurred in the Khorassan Province of Iran (4). This lack of information is particularly acute for the regions away from the largest population centres of Mashhad and Nishapur in the north and Qain and Birjand in the south, and greatly impedes the assessment of the early regional seismicity of east Iran. In the Dasht-e Bayaz and Gonabad basins which were devastated by the earthquake of 1968, and in the Kashmar and Torbat-e Heidariyeh region, it is only after about 1900 that the data becomes sufficiently precise to be used in seismotectonic and seismicity studies. In the latter region in particular, despite a recorded legend which mentions frequent devastating earthquakes (5) and the presence of the major active Dorunch Fault, only two destructive earthquakes are known in any detail, the Kashmar (Turshiz) earthquake of 1903 and the Torbat-e Heidariyeh (south) earthquake of 1923. These two events thus take on a special importance in studies of regional seismicity, and it becomes essential that they should be documented as accurately as possible. The present note summarizes some new bibliographical and field data on these two earthquakes and on some smaller earthquakes in the region.

1.2 *The Dorunch Fault*

The tectonics of the Kashmar-Torbat-e Heidariyeh region are dominated by the Dorunch Fault, a major element in the structure of Iran, second only in importance to the Zagros "Thrust" in the southwest of the country. In the region considered here, the Dorunch Fault is broadly east-west in direction and concave towards the south (Fig. 1). It separates the Kuh-e Surkh mountain range in the north from the Kavir-e Namak basin in the south and crosses over most of its length Recent and contemporary sediment fan formations. A recent field reconnaissance to the region found evidence that the latest displacements on the fault were predominantly vertical and in the sense of elevating the northern mountain block with respect to

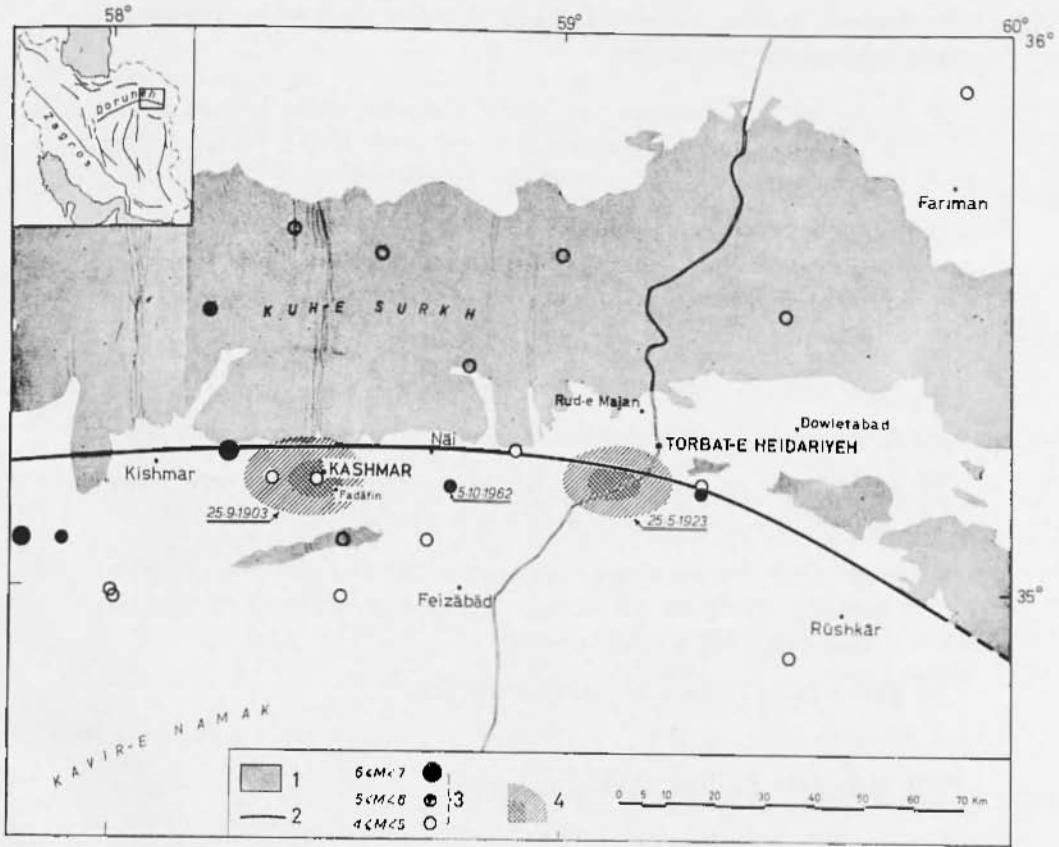


Fig. 1 - KASHMAR-TORBAT-E HEIDARIYEH REGION.

1. Regions above 1500 m; 2. Dornich Fault; 3. Magnitude of instrumentally determined earthquakes; 4. Epicentral region of destructive earthquake: hatched, villages affected; cross-hatched, villages completely destroyed.

the basin (12). The reader is also referred to Wellman (14) and Gansser (6) for more information on the tectonics of the region.

2. - KASHMAR (TURSHIZ) EARTHQUAKE, 1903

2.1 Documented shocks in 1902 and 1903

A few shocks are known for the pre-instrumental period as they were reported by Almazov (1), the russian military doctor resident

in Torbat-e Heidariyeh and in charge of meteorological, seismological and intelligence information.

- 20 July, 1902: two consecutive shocks damaged some houses about 7 km northwest of Torbat-e Heidariyeh in Rud-e Majan. The shocks were not felt in Torbat-e Heidariyeh (1);
- 10 January, 1903: an earthquake occurred at 13^h 18^m local time and was felt with intensity IV (Rossi-Forrel?) in Torbat-e Heidariyeh. It was most severe in Dowletabad 28 km east of Torbat-e Heidariyeh, but did not cause any destructions (2);
- 19 June, 1903: a slight shock was felt in Torbat-e Heidariyeh (2);
- 20 June, 1903: a slight shock was felt in Torbat-e Heidariyeh (2);
- 21 June, 1903: two shocks occurred at 06^h 58^m, the first one being of intensity III (Rossi-Forrel?) in Torbat-e Heidariyeh (2);
- 22 June, 1903: an earthquake occurred at 23^h 48^m and was felt with intensity V (Rossi-Forrel?) in Torbat-e Heidariyeh. The inhabitants fled to the streets (2);
- 24 June, 1903: a shock was felt at 01^h 03^m (2).

2.2 Kashmar (Turshiz) earthquake, 1903

The earthquake occurred on the 25 September, 1903 at 02^h 31^m local time and was described in detail by Almazov who visited the site shortly after the event (2). His report, given here *in extenso*, constitutes the only eyewitness account of the event and is probably very accurate on most of its points. The present-day town of Kashmar was called Turshiz up to the first decades of the 20th century.

"*Turshiz, Persia.* At 2^h 31^m an earthquake occurred in the form of several abrupt shocks of which up to 20 were counted. The direction of the earthquake in the general opinion was from the northwest, its duration 25-30 seconds, its intensity (1) IX. The earthquake preceded an underground noise. After the earthquake the water in the wells increased, as well as in the qanats, especially in the qanat at *Fadafin*, 2 versts (2) from Turshiz, where it was said that the flow of water doubled. Out of 1200 houses in Turshiz (3) half were destroyed, about 400 were severely damaged, and the rest were slightly

damaged. Houses of unbaked and mixed bricks suffered most, and thick walls made of kiln bricks were fractured in places but not destroyed; in the mud houses generally the domed roofs which were usually made of unbaked bricks collapsed, the annual layer of clay spread on the roof and which increased its thickness up to $1\frac{1}{2}$ arshin (4) being partly responsible for this collapse. The southern part of the town and the northeastern suburbs were particularly damaged, as well as the nearest villages. The area of destruction extended to a radius of 20 versts with the centre at Turshiz, in the west the destruction extending to 35 versts. There is information that the shock was felt in *Bijistan*. Walls collapsed in all directions (5), in some places in one direction, in other places in another direction, and elsewhere yet in another direction, but nevertheless, as if the walls which were spared were oriented west or northwest, thus indicating the direction of the earthquake shock. The angle with respect to the horizontal of the fissures in the houses were approximately 90° . The town is located in a valley, in the north the mountains are 8 versts away, and in the south 20 versts; in the northern mountains occurred rock-falls of several hundred puds (6). The soil is loess, in places mixed with clay. 25 villages were destroyed or affected (7).

During the time that I stayed in Turshiz to collect information on this earthquake, from the 29th of September to the 7th October, there were up to 40 ground shocks. The strongest occurred on the 30th September near sunset; it lasted about 5 seconds and caused the destruction of some houses in the town and in some villages; on that same day during the last three hours there were six more shocks,

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- (1) Presumably in the Rossi Forrel scale;
 - (2) 1 verst = 1.06 km;
 - (3) In 1894 the town was described as covering an area of about $1\frac{1}{2}$ km² and containing about 1200 houses (Baumgarten, 1896);
 - (4) 1 arshin = 71.12 cm.
 - (5) This obviously refers to the town of Turshiz, and not to Bijistan;
 - (6) 1 pud = 16.38 kg;
 - (7) There were between 80 and 120 villages in the vicinity of Turshiz, with an average of about 60 houses per village and a total population, excluding Turshiz, of about 24,000 (Baumgarten, 1896);
 - (8) The population of Turshiz was about 6000 (Baumgarten, 1896);
 - (9) The last reported aftershock was felt in Turshiz on the 17th December 1903 about 40 minutes before sunrise.

though not strong (intensities from III to V), yet distinctly felt (the observers at this time were either in movement or sitting on the floor). Altogether, the shocks during this day occurred either at sunset or shortly after. 100 people were killed in Turshiz (8), two having died the first day of their injuries; there were more than 100 injured. In the villages (7) one counted 99 killed and 161 injured, but there were surely more. (V. Almazov, Director of the Center for Medical Observation in Torbat-e Heidariyeh)".

"*Torbat-e Heidariyeh*, Persia. At 2^h 28^m there occurred an earthquake which lasted 25 seconds. The direction of the earthquake was in the opinion of most of the inhabitants from the northwest, and the intensity VI. The earthquake was accompanied by a strong underground sound which started about 5 seconds before the earthquake and produced at first the impression of a distant thunder and rumble of a storm. Doors and windows banged violently, beds swayed, and the crockery rattled. During this time the earth was moving in Turshiz. Of the shocks that followed in Turshiz the strongest occurred on the 30th September. It was also felt in Torbat-e Heidariyeh, but not so strongly. During the night of the 10th to 11th October at about 21^h 3^m there again occurred an earthquake of intensity about IV (9) (V. Almazov, Director of the Centre for Medical Observations)".

It seems likely that Almazov did not visit personally the villages around Turshiz and that the area of destruction which he mentions should be interpreted as the area over which villages were affected by damage of some sort albeit not necessarily severe. The houses in the region, being entirely of adobe and sun-dried brick, would be fissured at very low intensities, but the small number of casualties in these villages suggests that completely collapsed houses were the exception. The casualty figures given are probably as reliable as could possibly be obtained at the time because Almazov's mission in Turshiz was the organization of medical relief and aid from his hospital in Torbat-e Heidariyeh. Sykes who visited the town in 1904 also noted that Turshiz "suffered considerably during the earthquake of 1903, which fortunately affected only a small area" (11).

3. - TORBAT-E HEIDARIYEH (SOUTH) EARTHQUAKE, 1923

The earthquake occurred on the 25th May 1923 at 22^h 21^m GMT (26 May 1923 at 02^h 21^m local time) and is attributed a magnitude

ranging between $5 \frac{1}{2}$ and 6 (^{s. s.}). The field studies reported below have established that the epicentral region was centered about 8 km southwest of Torbat-e Heidariyeh. Contrary to the indications of several earthquake catalogues, [Sieberg (¹⁰), repeated by Rezanov (⁹), and others], the town itself was not affected and did not suffer any casualties. However, as the event is already known as the "Torbat-e Heidariyeh earthquake", this name will be retained here with the addition of "south" to indicate that the earthquake affected a region south of the town.



Fig. 2 - RUINS OF QAL'EH NOW VILLAGE DESTROYED BY THE 1923 EARTHQUAKE.

The village was at the southeastern limit of the epicentral region and was only partially destroyed. The houses which survived and are still inhabited to-day can be seen in the background.

The ruins of some of the destroyed villages are still visible to-day (Fig. 2) and many of the survivors are still living in the region and can recount the details of the event. By cross-reference between the different villages and comparison with the occasional contemporary press report, the reliability of this information was generally found

to be high. The epicentral region was located along, and south of, the Doruneh Fault, and included 5 villages which were completely destroyed: Hoz Sorkh (formerly Murtazavieh), Guju (formerly Kuzan), Khurg, Taghiabad and Kaj Darakht (Fig. 3). The destruction decreased rapidly away from this region: in Buriabad, many houses collapsed, but the Mosque still standing to-day suffered practically no damage at all, and in Qal'eh Now only one half of the houses needed reconstruction (Fig. 2). In Shadmehr, only a few houses collapsed completely even though the village was eventually reset south of its original position. Casualties and approximate populations of the time for these villages, as remembered by the surviving inhabitants, were as follows:

Hoz Sorkh (Murtazavieh) killed	170	population	300
Guju (Kuzan)	300		700
Khurg	110		200
Kaj Darakht	70		175
Buriabad	64		600?
Qal'eh Now	8		100
Shadmehr	27		650

The above list is not complete as some of the villages around the epicentral region were not visited and others produced inconsistent results which were not considered sufficiently reliable. Furthermore, a few villages are to-day no longer inhabited (eg. Taghiabad), and others which bear multiple names (eg. Hoz Sorkh-Murtazavieh-Sadrabad) may indicate that after 1923 some villages were regrouped rather than rebuilt individually. In view of these considerations, the official figure of 2,219 killed and 170 severely injured given at the time by the Governor General seems reasonable and moreover corresponds to the impression gained from contemporary news reports⁽¹⁹⁾.

The extent of the area where damaged occurred can be defined quite accurately and does not exceed 10 km from east to west and 5 km from north to south (Figs. 3 and 4). Outside this area, damage was insignificant or nil; Zarmeh, Zarmihr, Zahirabad and Iskandarabad, situated respectively northwest, west, southwest and south Shadmehr and all less than 10 km away from this village, were practically unaffected. Similarly, Alahabad, situated about 10 km southeast of

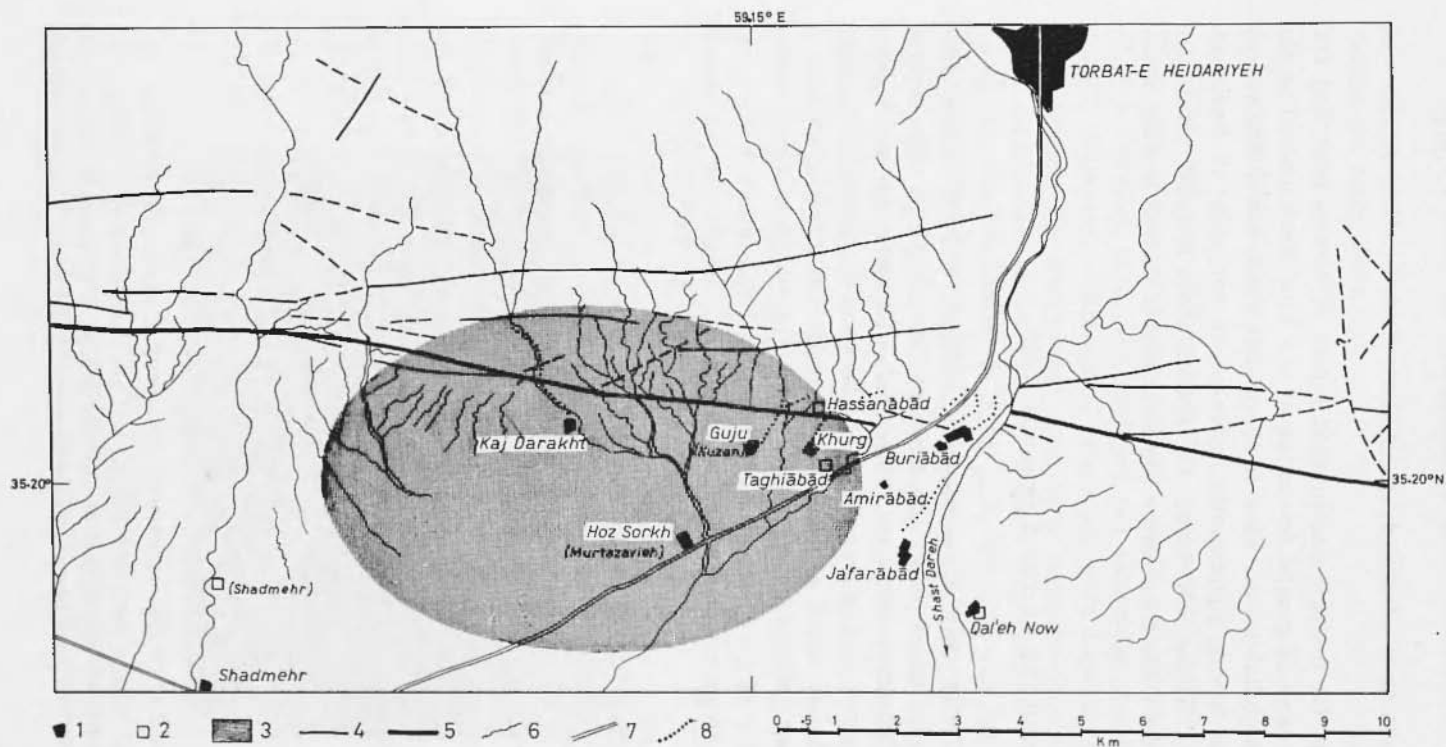


Fig. 3 - EPICENTRAL REGION OF THE TORBAT-E HEIDARIYEH (SOUTH) 1923 EARTHQUAKE.

- 1) Village destroyed or damaged; 2) as 1 but uninhabited to-day; 3) approximate region of total destruction; 4) fault; 5) youngest fault trace; 6) stream bed; 7) Mashad-Birdjand road; 8) qanat.

Qal'eh Now, and, as already mentioned, Torbat-e Heidariyeh, were undamaged.

Except for a single unconfirmed report of fissures near Kaj Darakht, no cases of ground fracturing of any kind were noticed at the time by the inhabitants. Flow in the qanats was however consistently reported as having significantly increased, in particular in Buriabad, Hoz Sorkh, Khurg and Guju. In Iskandarabad, a qanat which had been dry for some time before the earthquake, started flowing again.

4. - EARTHQUAKE OF THE 5 OCTOBER, 1962

After 1923, only one earthquake is known to have caused some destruction in the regions crossed by the Dorunch Fault. It occurred on the 5 October, 1962 and the instrumental epicentre was located south of the Fault and about mid-way between the 1903 and the 1923 events (Fig. 1); the magnitude was estimated at 5. The villages of Ahmadabad, Mahmalad and Rizteh (?) situated in a region about 10 km south of the instrumentally determined epicentre were severely damaged. 6 people were killed and 3 injured, most of the population



Fig. 4 - 1923 EPICENTRAL REGION SEEN FROM THE EAST.

The nearest village (left) is Buriabad and the furthest, Kaj Darakht. The fault zone passes east (right) of the hill behind Kaj Darakht and crosses the Shast Darreh flood plain towards the centre-right edge of the photograph.

having apparently been forewarned by a foreshock about 5 minutes before the main shock (3).

5. - CONCLUDING REMARKS

The 1903 and 1923 earthquakes have several points in common. They each affected small areas situated along, and immediately south of, the Doruneh fault, and probably not exceeding about 10 km in largest dimension. Epicentral intensities were high in these areas even though the magnitudes were only moderate (5.5 to 6 in the 1923 earthquake) indicating very shallow hypocentres. The shocks near Torbat-e Heidariyeh in 1902 and 1903, and the earthquake of 1962 also affected very localized areas, and the other instrumentally determined earthquakes in the region are all of magnitude 6 or under, with one exception on 4 May 1940 with magnitude 6.5 (Fig. 1). More data on pre-1900 earthquakes is however required to establish whether this type of earthquake which seems to be characteristic for the region during the 20th century also prevailed during earlier times.

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