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EARTHQUAKES III. IN PERSIA

iii. IN PERSIA

Sources and state of current knowledge. Based on numerous but fragmentary observations of earthquakes over a long period of time, it is only since the middle of the 20th century that there has been an attempt at systematic study of seismic activity in Persia and that macroseismic data collected at international stations have been refined in relation to the Persian situation, through the establishment of a network of local seismological stations, in Tehran (1337 Š./1958); Shiraz (1338 Š./1959); Safīdrūd (1341 Š./1962); Tabrīz, Mašhad, and Kermānšāh (1343-44 Š./1964-65); Būšehr (1354 Š./1975); Isfahan (1355 Š./1976); and Sāva (1356 Š./1977), each the center of a constellation of substations. After early, incomplete, and imperfect attempts at cataloguing earthquakes in Persia (A. T. Wilson), the first comprehensive seismotectonic map of the country was published; it was limited to north central Persia and was drawn to a scale of 1:1 million (Tchalenko et al.). It was soon followed by a map of the entire country, drawn to a scale of 1:2.5 million, with supplementary maps of the epicenters of destructive earthquakes in the period 1318-96=1279-1355 Š./1900-76, of the principal faults in the country, and of earthquakes recorded since the 4th century B.C.E., all drawn to a scale of 1:5 million (Berberian). The historical study was taken up again in a fundamental work by N. N. Ambraseys and Charles Melville (1982), who drew upon a much broader range of documentary sources; their work is a model of its kind, encompassing not only a general study, but also reconstructed maps of the areas of destruction connected with a number of major historical earthquakes.

More recently these data have been integrated into a much less detailed synthesis and then into a general seismic map of the entire Near and Middle East (Schöler and Bauer; Schöler). Nevertheless, it must be admitted that our knowledge of past earthquakes is still insufficient, owing particularly to the extreme unevenness of the documentation for different regions; indeed, for many sparsely populated desert areas it is almost entirely absent, both from textual sources and from the archeological record. The broad outlines of seismotectonics have thus been established, but they cannot yet be filled in without some hesitation and approximation.

General features of the seismological geology of Persia. The main relevant feature is the great Zagros fault line, where the Arabian and central Iranian plates overlap. In this zone, 1,600 km long and on average 250 km wide, seismic activity is extreme. Historical data suggest that there has been continuous seismic activity, with occasional local tremors, but chiefly a large number of mild earthquakes bearing little relation to tectonic fractures in the region or to visible traces of recurrence; nor can they be linked with major faults. In certain parts of the Zagros nomadic tribes report that the earth trembles more or less regularly every year, setting off notable rock slides. At Bandar-e ʿAbbās in 1031/1622, besides a major earthquake on 28 Ḏu'l-qaʿda/4 October, there were six or seven minor tremors, but the residents reported to a European traveler that there was usually an average of only one earthquake a year (Della Valle, III, p. 590). Altogether, however, this zone seems to have been relatively free from major earthquakes, and, despite continual deformation of the earth's crust, most episodes have had no serious seismic consequences. Throughout its history Shiraz has experienced numerous tremors in which varying numbers of buildings have collapsed, but only one truly cataclysmic earthquake, that of 26 Rajab 1269/5 May 1853, in which about 9,000 people died.

Northeast of the Zagros central Persia corresponds broadly to a mosaic of Gondwanian plates, the details of which have not yet been sufficiently defined; altogether, they constitute a stable zone. Major earthquakes are rare there, and it is the region in which the largest number of early minarets are preserved (at Isfahan, Yazd, and Kermān; for Isfahan, see Ambraseys, 1979). Earthquakes there seem to be essentially local reverberations from major events in other regions. Movements resulting from the subsidence of the Zagros are, however, transmitted through the central Iranian plates toward the northern and eastern zones, tracing a gigantic triangle.

These northern and eastern zones thus experience the most intense seismic responses to the general drift of Arabia toward Eurasia. It is there that most serious earthquakes occur, throughout the length of the so-called Iranian Crescent, which extends from Azarbaijan through the Alborz, Khorasan and the Kopet Dag, Kūhestān, and Sīstān east of the Dašt-e Lūt as far as Makrān, for which sources are rare. Important earthquakes can also occur in the regions of central Persia along the edges of the Iranian Crescent, thus in the Ṭabas (earthquake of 27 Šahrīvar 1357 Š./16 September 1978, which left 6,300 dead, 3,600 in the town itself) or in the fault area around Kāšān (15 Ḏu'l-qaʿda 1192/15 December 1778, in which more than 8,000 died). This seismic activity between tectonic plates does not appear to depend on the apparent surface tectonics or on the major Quaternary faults; rather it is correlated with minor faults, tilted and sometimes very recent, that have cut across earlier instances. Relatively long periods of quiescence separate major paroxysms, which thus seem totally unpredictable. For example, Nīšāpūr was affected by serious cataclysms in 605/1209, 669/1270, 808/1405 (leaving 30,000 dead), and 1084/1673 but has remained almost free of earthquakes since (Melville, 1980). Only Azarbaijan, particularly in the region of Tabrīz, is distinguished by apparently continuous seismic activity. More or less severe shocks were experienced in the city in 244/858, 434/1042, 672/1273, 704/1304, 746/1345, 864/1459, 957/1550, 1060/1650, 1068/1657, 1075/1664, 1130/1717, 1134/1721, 1195/1780, 1235/1819, 1253/1837, 1259/1843, 1273/1856, 1314/1896, and 1349=1309 Š./1930; those of 434/1042, 1134/1721, and 1195/1780 were particularly destructive, each doubtless causing 20,000-50,000 deaths. It has been suggested that seismic activity alternates somewhat between the northern and eastern parts of Persia, the former seeming to be enjoying a period of relative calm at present (with the exception of the Rūdbār earthquake in 1990), while the latter is undergoing a peak of activity (Ambraseys and Melville, p. 153).

Earthquakes in the beliefs and daily life of the Persians. In Persian popular belief the origins of earthquakes are attributed to the position of the globe on the horns of a bull, itself resting on a fish. When the bull is tired or, according to others, when there is too much injustice in the world, he becomes impatient and shifts the globe from one horn to the other, with resulting earthquakes. Some people claim that earthquakes occur where the earth falls directly onto the bull's horn (Massé, *Croyances et Coutumes* I, p. 181). This notion is actually quite widespread all across the Islamic civilization of the Middle East, but Persian versions can be adduced, interpolation showing the influence of

Shiʿism. The earthquake that destroyed Qūčān in Khorasan in 1313/1895 was explained by the fact that a son of the Imam ʿAlī al-Reża, whose tomb is located there, had gone to visit his father, who is buried at Mašhad, thus leaving the city defenseless against the elements (Donaldson, p. 264).

Recourse to astrologers was common during cataclysmic occurrences, and there were also individuals who predicted earthquakes. The astrologer Abū Ṭāher Šīrāzī was reported to have predicted the exact date of the earthquake that destroyed Tabrīz during the night of 14 Ṣafar 434/3 October 1042 and killed more than 40,000 people. He was consequently chosen to direct the reconstruction of the city and announced that in the future Tabrīz would no longer be in danger. Ḥamd-Allāh Mostawfī, writing in 741/1340, noted that the prediction had proved correct (*Nozhat al-qolūb*, ed. Le Strange, pp. 75-76; tr., pp. 78-79; Ebn al-Aṯīr, IX, p. 513). After an earthquake at Urmia in 1300/1883 an astrologer from Tehran sent a telegram informing the population that the earth would continue to tremble for forty days. Armenian priests consulted their books and announced a new shock for the next morning at 11 o'clock. A mulla from Tabrīz predicted an aftershock for the following Sunday at 2:00 p.m., which set off a panic among the population. As his prediction did not come true, the mulla was arrested (S. G. Wilson, pp. 224-25). On 21 Jomādā I 1261/28 May 1845, at about four hours before nightfall, a tremor was felt 2 parasangs (ca. 14 km) from Mašhad just at the place where the European traveler J. P. Ferrier was preparing to camp for the night; his guide concluded that the tremor was a bad omen and moved the camp (Ferrier, I, p. 260).

In such a situation of permanent danger it is paradoxical that no systematic adaptation of traditional Persian construction techniques to the frequency of earth tremors has been attempted, at least until very recently (Ambraseys and Melville, p. 25). After the great earthquake of 1194/1780 at Tabrīz the inhabitants began to build their walls as low as possible, using wood instead of brick and stucco, and to roof the *bāzār*s with planks, rather than with domes (Morier, pp. 278-79). Nevertheless, in 1232/1817 they again rebuilt the city walls to a considerable height (Johnson, p. 212). In the same city it was apparently Westerners in the service of the crown prince ʿAbbās Mīrzā who first introduced construction methods that provided a certain security, particularly wood-frame structures with flexible joints (known as *taḵta-pūš);* while such methods seem to have been reserved for temporary shelters in gardens (Ker Porter, II, p. 502), the old houses were rebuilt in the traditional fashion. After the earthquake of 1288/1871 at Qūčān a new type of emergency

shelter appeared: beams removed from the ruins were assembled in "A" frames or used as ridge poles, the walls being plastered with earth (MacGregor, II, pp. 85-86). When such a house had to be enlarged, an identical building was constructed parallel to the first and the space between enclosed with walls and covered with a flat roof. Houses of this type, consisting of one to three rooms, withstood the earthquakes of 1311/1893 and 1313/1895 and were still in place in 1322/1904 (Huntington, p. 236, pl. 27). But these ephemeral improvements do not seem to have had any long-term impact. In the 1960s there were private attempts in the comfortable neighborhoods of northern Tehran to bring spherical houses, already ill-adapted to the sloping terrain, up to antiseismic standards (Ambraseys and Melville, pp. 25-26, pl. 26), but no official regulations were ever adopted. In fact, Persia, which includes some of the most seismically active regions in the world, seems never to have been seriously concerned about the danger and the need for preventive measures. Daily life is marked by indifference and appears not to have been noticeably affected by major episodes. The historical repercussions have been none the less significant, particularly for the fates of certain cities. The decline of Qūmes in the 9th century, of Sīrāf in the 11th, and of Nīšāpūr after the 12th-14th centuries seems to have been largely owing to destructive earthquakes (Ambraseys and Melville, p. 109).

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