Early Earthquake Detection and Warning Alarm System in Iran by a Telegraph Operator: A 116-Year-Old Disaster Prevention Attempt

by Manuel Berberian[1]

According to an article printed in 1909 in a local Iranian newspaper, the *New Iran* (*Irān-e Nau*; Fig. 1), a telegraph operator at the remote desert town of Kermān in southeast Iran, using coils of a single wire with return circuit through the ground of his telegraph instrument, picked up the Earth's movement as an unusual electromagnetic signal on the magnetic needle, which gave a few seconds warning of an earthquake. Apparently, the operator was using a Wheatstone/Cooke-type needle magneto-electric telegraph built in the late nineteenth century.

He first noticed this anomaly on his telegraph instrument during an earthquake in 1897. Two medium-magnitude earthquakes during that year were strongly felt and documented in Kermān. These were (1) the 22 May 1897 MMI ~ VII$^+$ $M_S \sim 5.5$, Kuhbanān earthquake with its epicenter about 145 km northwest of Kermān; and (2) the 27 May 1897, MMI ~ VIII $M_S \sim > 5.5$ Chatrud earthquake located about 25 km north-northwest of Kermān (see fig. 3 in Berberian, 2005).

The telegraph operator observed that the first earthquake took place during the evening, suggesting that he was referring to the 27 May 1897 event. His second observation of a seismically induced disturbance was during the 27 October 1909, $\sim M_S > 5.5$, MMI > VII$^+$, Jowshān earthquake, with its damage zone located about 58 km to the east-southeast of Kermān (fig. 5 in Berberian, 2005). The article, translated below from Persian into English, is signed by "Yusef Telegerāfchi va Tahvildār-e Telegerāf-khāneh-ye Kermān" ("Yusef /Joseph, the telegraph operator and cashier of the Kermān Telegraph Office"). The article was printed nine months after the occurrence of the largest post-1900 intracontinental earthquake of 23 January 1909 M_S 7.4 in Iran, which killed more than 8000 people and demolished more than 130 villages and a town.

> *A Discovery Deserving Attention: Twelve years ago [in 1897] during the evening while I was working on the telegraph instrument, the magnetic pole of the telegraph instrument had an unusual movement which astonished me. After a few seconds an earthquake occurred. I was sure that because the electrical current of the Earth was agitated, the current passed through the two coils of wire which resulted in deflection of the magnetic needle. It is, therefore, possible to build a more sophisticated instrument which can signal an imminent earthquake. If I try my best I can save the lives of people within a few vital seconds. I understood the concept but twelve years ago when the magnetic needle showed an extraordinary move I could not do anything. Since then, with such difficulty and limited tools, I built a few wire coils at home but they were not satisfactory.* (Irān-e Nau Newspaper, 1909).

After describing the principles of the coils of copper wire and magnetic needles that he was using when the earthquakes were sensed, he added that:

> *One of the two wires of the coil is connected to the ground in a well, and the second wire is connected to a pile of a battery. Another wire is connected to the coal rode of the pile, and the end is grounded in a well about 50 m away. For some reason about four years the current was not connected, and there was no earthquake in Kermān. The circuit was then connected and remained as such for a few years until in the month of Shawwal of the year 1327 [October 1909] about four hours after the night [i.e. after sunset] when I was sitting by the same desk where I experienced the anomaly 12 years ago [in 1897], the circuit current completed, and the needle deflected. I immediately took my clock and left the office room and informed the inhabitants of the house to rush outdoors. After six seconds an earthquake occurred [the October 27 1909 event]. I do not know if this anomaly has been tested in Europe. Anyway, because of the ground motion, the power in the Earth was excited and passed through the land between the two mentioned wells with grounded wires inside. The electricity passed through the pile of the battery as well as the coils and, therefore, deflected the magnetic needle to the right and left. It was six seconds after this anomalous observation that the earthquake occurred. As the knowledgeable people know, this happens in an eye blink and does not take much time.*
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> *I am confident if a more sophisticated instrument is built, a few minutes after the needle's anomalous move, the earthquake will be felt. And if the system is connected to a big bell [an alarm system], it can be heard by all the people, and their lives will be saved.*

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Yusef, the telegraph operator and cashier of the Kermān Telegraph Office, Joseph K. M. (Irān-e Nau Newspaper, 1909).

Apparently, during the nineteenth century the telegraph officers and operators throughout the world were aware of the effects of natural phenomena on the electric telegraph lines and disturbances observed in the magnetized needles of the instruments. On 19 February 1822, M. Arago (in Prescott, 1860) observed an extraordinary agitation in the needles of diurnal variations during a strong earthquake in Auvergne at Lyons, France, and in the Switzerland. He likewise observed in Valdivia, Chile, a very remarkable disturbance in the magnetized needle at the period of a strong earthquake in February 1836 (Prescott, 1860).

Dr. James Hector (1834–1907), director of the New Zealand Geological Survey (in Hooker, 1870), in August 1869 wrote about the use of the electric telegraph for "recording" natural phenomena such as aurora, tornados, and earthquakes. In October 1875, M. Rivet, the telegraph superintendent at Fort de France, Martinique, Caribbean Sea, noticed that each of the September 1875 earthquakes at Martinique were preceded by a very marked disturbance of the electric telegraph needles (H. M. C., 1881). Rivet suggested that in this way "warnings" otherwise unattainable of impending shocks might be obtained.

Telegraph disturbances were also recognized during strong aftershocks of the 12 June 1897 M_w 8.1 Shillong, Āssām, India earthquake, where it was linked to the currents in the ground (Oldham, 1899; Bilham, 2008). The return circuit through the ground described by the Kermān telegraph operator seems to be similar to a single conductor Earth return shown in figure 10A in Bilham (2008), where the induced Earth potentials during the earthquake reduced or reversed the current induced by the battery in the Earth-return circuit (fig. 10A in Bilham, 2008).

Hence, there seems to be a likelihood that the telegraph operators throughout the world were somehow aware of the phenomenon. Nonetheless, the attempt to transfer knowledge, experiment, and the experience in earthquake warning alarm system by the Iranian telegraph operator in 1897 and 1909 was priceless. This seems to be the first concept of an earthquake early warning system based on ground shaking somewhere close to the epicenter that caused an unusual electrical impulse to travel down the telegraph wires and affect the equipment of the Kermān operator over a century ago. The fact that Yusef's observation and idea made its way to a local newspaper in Iran in 1909 and has been preserved for over a century is interesting by itself, regardless of Yusef's prior knowledge of the phenomenon. We should remember that when Yusef's article was printed in the Persian newspaper in Iran, the literacy rate of the country was 1%–5%, only a few newspapers existed, and the total number of elementary schools was 21 in the country, 17 of which were in the capital city of Tehran (UNESCO, 1970; Bharier, 1972; Amirahmadi, 2012). Furthermore, under the Anglo-Russian agreement of 31 August 1907, the country was occupied and divided into the British and Russian influence spheres.

Apparently, the main concept of an early warning system was properly introduced by J. D. Cooper, M.D. in 1868 (printed in *The San Francisco Daily Bulletin*, 1868). Dr. Cooper's concept, which was published about 29 years before the Kermān telegraph operator's idea and 41 years before his article printed in the Iranian newspaper, was explained as follows:

A very simple mechanical contrivance can be arranged at various points from 10 to 100 miles from San Francisco, by which a wave of the earth high enough to do damage, will start an electric current over the wires now radiating from this city, and almost instantaneously ring an alarm bell, which should be hung in a high tower near the center of the city. This bell should be very large, of peculiar sound, and known to everybody as the earthquake bell. Of course nothing but the distant undulation of the surface of the earth should ring it. This machinery would be self-acting, and not dependent on the telegraph operators, who might not always retain presence of mind enough to telegraph at the moment, or might sound the alarm too often. As some shocks appear to come from the west, a cable might be laid to the Farallon Islands, 25 miles distant, and warnings thus given of any danger from that direction. Of course there might be shocks, the central force of which was too near this city to be thus protected, but that is not likely to occur once in a hundred times. (Cooper, 1868).

Although probable, it is unlikely that the telegraph operator in the small and remote desert town of Kermān at the edge of the Lut desert in 1897–1909 had access to American newspapers, and he was probably unaware of Dr. Cooper's concept published 29 years before his first earthquake early warning experience in 1897.

Almost 40 days before Dr. Cooper's concept was published in *The San Francisco Daily Bulletin* on 3 November 1868 and 29 years prior to the 1897 Āssām, India, earthquake, which showed telegraph current interruptions and reversals (Oldham, 1899; Bilham, 2008), there was another article in the Iranian State Newspaper (Ruznāmeh Daulati, 1868) published in the capital city of Tehrān.

The article was about an observation by an anonymous writer about earthquake forerunners (poor telegraph communication signals during foreshocks, abnormal animal behavior, and sulphurous odor) which took place on 30 August 1868 in the central Kavir [desert] of north-central Iran. Due to the remoteness and sparse population of the central Kavir, the epicentral region, and hence the causative fault of the earthquake, is not known (Ambraseys and Melville, 1982; Berberian *et al.*, 1985; Berberian, 1994). The earthquake was strongly felt in the cities around the central Kavir, including Tehrān to the northwest, Qom in the west, Kāshān in the southwest, and Firuzkuh in the north (Berberian *et al.*, 1985).

..Also, on the night of 11 Jumāda-I 1285 [30 August 1868], four hours and forty minutes after the night

▲ **Figure 1.** Yusef the telegraph operator's 1909 account of his observations of unusual electromagnetic signals detected just before earthquakes in 1897 and 1909.

[sunset] a strong earthquake took place in Tehrān, Kāshān, Qom, and Firuzkuh. On the day of 10 Jumada-I [29 August 1868], great difficulty and poor reception were experienced in telegraph line communications. It is experienced that the strength of the electricity of the Earth becomes disturbed one or more days before an earthquake. Therefore, it results in difficulty in communication by telegraph. In the European observatories, where they have special instruments, they always predict that an earthquake will occur after about ten hours!

During the same night, before the ground movement and earthquake, animals such as four-legged ones [beasts of burden] and birds suddenly cried out, and a stinking sulphur-like odor was noticed by most people, resulting in nausea. And since the smelling membranes of animals are more sensitive than those of human beings, it is possible that this odor was the cause of the cry of the animals. It is the trapped fumes inside the Earth, that, because of an earthquake, emerge from the pores and fractures in the ground. And it is possible that the striking odor was responsible for increasing diseases after the earthquake. Also, on Friday night of 23 Jumāda-I [11 September 1868], five hours after the night [sunset], a slight earthquake occurred. (Ruznāmeh Daulati, 1868).

Not withstanding the long list of abnormal phenomena associated with the 1868 large earthquake, the writer, who possibly was another telegraph operator, noticed unusual telegraph disturbances prior to an earthquake occurrence, and broadly attributed it to the electricity disturbances of the ground.

Dr. Cooper in San Francisco, California, Yusef the telegraph operator in Kermān, and the second telegraph operator in Iran during the late nineteenth century, as well as several others throughout the world, noticed that the ground shaking at a distant location could initiate unusual electric impulses that would travel down the telegraph wires and affect distant telegraph stations. Although Dr. Cooper's idea was first put into practice in Japan in the 1960s and 1970s (Nakamura, 2004, 2006; Nakamura and Saita, 2007; Allen *et al.*, 2009), no one in Iran put the Kermān telegraph operator's early warning system concept into practical use after its publication in the Persian newspaper in 1909. Ironically, the 2003.12.26 M_w 6.6 Bam urban earthquake, which killed more than 40,000 people and demolished the city of Bam (Berberian, 2005), took place 180 km to the southeast of Kermān, where Yusef the telegraph operator was thinking of an early warning system and saving people's lives about 94 years prior to the unfathomable devastation caused by a medium-magnitude earthquake at Bam.

After the printing of Yusef's 1909 article, there was a 42-year silence in thinking and writing about the earthquake hazard in Iran, until 1951 when Professor Sedrāk Ābdāliān wrote about earthquake risk in the capital city of Tehran (see Berberian *et al.*, 1985). Sadly, by the 100-year anniversary of Yusef's article more than 164,000 Iranians had lost their lives during medium- to large-magnitude earthquakes, and no plans to develop earthquake hazard mitigation or early warning alarm system seems to be on the horizon.

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School of Science
Department of Mathematics, Science, and Technology
Ocean County College
Toms River, New Jersey 08754-2001 U.S.A.
manuel_berberian@ocean.edu

[1] Also at Onduni Grung Enterprise, 1224 Fox Hollow Drive, Toms River, New Jersey 08755-2179 U.S.A.