PALEOSEISMOLOGY IN IRAN; AIMS, PREVIOUS RECORD AND FUTURE PANORAMA

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ABSTRACT *Being placed in Alp-Himalaya orogenic belt, Iran is one of the most geologically active regions in the world. Northward movement of the Arabian plate and stability of the Turan plate in the north has caused Iran plateau to become squeezed in between. All of these conditions have transformed Iran to one of the most exclusive places for occurring earthquakes in the world. The energy of earthquakes in Iran is released along the faults in different seismotectonic regions. Earthquake catalogues in Iran consist of instrumental and historical data. The Instrumental data are limited, in the most optimistic situations, to some decades ago. Historical data can go back to some centuries or a millennium. In the regions where earthquakes occur frequently with short recurrence intervals, for example in Zagros, by instrumental data bank we can have an assessment of hazard in this region. In north of Iran, Alborz-Azarbayejan province, Historical data can increase our knowledge in order to have an assessment of the hazard. In contrast, in the regions of E-NE of Iran neither Instrumental nor historical data can reveal the history of occurring earthquakes in the past. In these parts of Iran the earthquakes occur with long recurrence intervals, much longer than our data range, so the role of paleoseismic investigations can be determined here to detect earthquakes that occurred some millennia ago. These investigations usually have been done by digging trenches across the faults to obtain some information such as:*

Determining the exact sense of movement of faults;

Identifying and dating paleoearthquakes on the faults;

Measuring the slip rate of the faults and the recurrence interval of the paleoearthquakes.

This information is then used for seismic hazard analysis of the regions specially where there are not enough data (instrumental and historical) for the assessment of the earthquake hazard. In this study we tend to deal with this kind of work; the aim of paleoseismic studies in different parts of Iran, the history of these studies and also the future panorama of this interdisciplinary subject.

INTRODUCTION

The Iranian plateau is a relatively wide zone of compressional deformation along the Alpine-Himalayan active mountain belt, which is entrapped between two stable platforms, the Arabian plate in the southwest and the Turan platform (Eurasia) in the northeast. Its deformation is related to the continuing convergent movement between the Arabian plate to the southwest and the Turan platform to the northeast, by north-northeastward drift

of Afro-Arabia against Eurasia. The north-south shortening from Arabia to Eurasia is ~2.5 cm/year. This lithospheric movement has led Iran to be one of the seismically active areas of the world and frequently affected by destructive earthquakes, imposing heavy losses in human lives and widespread damage. Five major seismotectonic provinces in Iran are delineated based on all available geophysical, geological, tectonic and earthquake data.

✓ Zagros represents continental-continental collision zone of Arabian plate and Central Iranian Microcontinent;

✓ Highly seismic region of Alborz-Azarbayejan in north and northwest Iran, constitutes a part of northern border of Alpine-Himalayan seismic belt;

✓ Continental collision zone of Kopeh Dagh in northeast is a northern segment of Alpine-Himalayan seismic belt which faces the Turan platform in the north;

✓ Oceanic-continental subduction zone of Makran in southeast is the site of consumption of oceanic crust of Arabian plate underneath Central Iranian Microcontinent and Eurasia;

✓ Central-East Iran is an Intraplate environment surrounded by the foregoing convergent zones.

PALEOSEISMOLOGY INVESTIGATIONS IN IRAN

According to the different seismotectonic provinces in Iran the characteristics of the earthquakes are different in each province.These characteristics include the maximum magnitude of each fault that can generate an earthquake, the slip rate of the faults and recurrence interval of the events occurred on each fault. The occurrence of big earthquakes and heavy damages to the cities in many parts of the country (e. g., Buin Zahra, Tabas, Manjil, Bam, Zarand, …) show that these characteristics have not yet been recognized. So in order to determine these parameters, paleoseismological investigations should be done in each region. Fig.1 shows the background seismicity in big cities of Iran. Here we mentioned some of the most important investigations done in Iran in order to recognize the characteristics of past earthquakes. Other studies were summarized in the Fig.2.

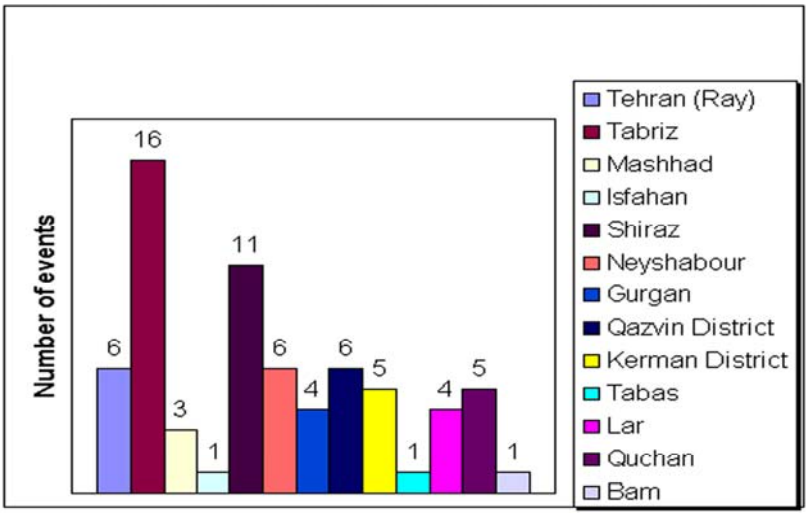

Fig-1. Historical seismicity of major cities in Iran

KAHRIZAK FAULT

Kahrizak project was the first time that scientific paleoseismological trenching was carried out in Iran and this work is intended as a first contribution to a modern assessment of the seismic potential in the area of Tehran based on geologic input. The fault forms an impressive scarp at the surface up to 15m high on Holocene alluvial deposits and results in the subsidence of the southern block. Two trenches were opened across the central part of the Kahrizak Fault. The results are as follows:

- ✓ Strike: N70-80W
- ✓ Dip: 70-80 N
- ✓ Rupture length: ~35 km
- ✓ Dating method: Radiocarbon
- ✓ Elapsed time from the last event: 5000-800 years
- ✓ Slip per event: 10 m
- ✓ Slip rate: Vertical= ~1mm/yr Horizontal= ~3.5 mm/yr
- ✓ Average recurrence time: ~3000 years
- ✓ Maximum expected magnitude: Mw 7.0 to 7.4

THE NORTH TABRIZ FAULT

The North Tabriz Fault is one of the active faults in NW Iran that has a clear surface expression. It has caused several damaging earthquakes; among them are 1721 and 1780 events. Northwest part of the fault was chosen for paleoseismological investigations within the rupture zone of the 1780 earthquake, with particular attention to the fault in the vicinity of the city of Tabriz. Two trenches were opened across the fault, perpendicular and parallel to the fault, each 100m apart. The results of this study have been summarized here:

- ✓ Strike: NW-SE
- ✓ Length: 150 km
- ✓ Sense of movement: Right-lateral
- ✓ Magnitude of lateral movement: 8m during late Holocene
- ✓ Slip per event: 4±0.5 m
- ✓ Slip rate: Horizontal= 3.1-6.4 mm/yr, 3.7-4.0 mm/yr based on incised alluvial fans by drainages and offset Qanats respectively; Vertical= 0.5-0.8 mm/yr
- ✓ Recurrence intervals: average recurrence interval 350 to 1430 years and a mean recurrence interval of 821±176 years based on chronological constraints in each trench.

KAZERUN FAULT

The Kazerun Fault, in Zagros, starts from near the town of Yasuj and goes southward. It is an active fault with the length of 100 km. For paleoseismological investigations one trench were opened across the fault. To summary we can say:

✓ At least two paleoearthquakes have occurred on the fault during last about 9 ka.

✓ During each of the earthquakes, vertical fault motion was around 1.5 m and caused the flexuring of the superficial strata.

✓ Based on long-term ratio between right-lateral and vertical components, net slip during each seismogenic fault movements can be estimated to have been 7.5 m.

SABZEVAR THRUST FAULT

The northward-dipping Sabzevar Thrust Fault is situated along the southern margin of the east-west trending Siah Kuh (Black Mountain) range in northeast Iran. Optically Stimulated Luminescence (OSL) dating was operated on samples derived from a natural trench in order to estimate the Holocene slip rate of the fault. The results are as follows:

✓ The rate of slip is in the range 1.5-2.1 mm/yr

✓ The recurrence interval between large earthquakes is around 3000 years.

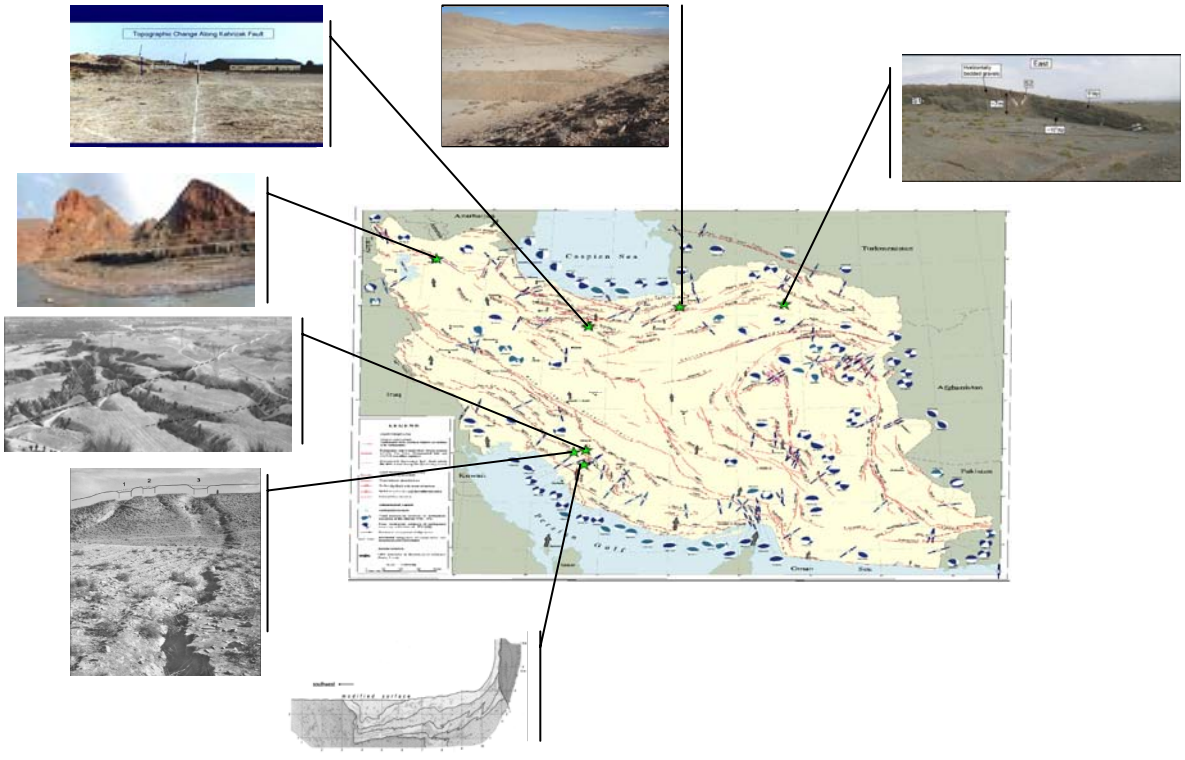

Fig-2. Paleoseismology works in Iran

CONCLUSIONS

According to Fig.2 there are many great unknown faults across the country that threat human life in Iran. In order to have a reliable estimation of the seismic hazard in Iran determining the characteristics of these faults is necessary. Lack of knowledge about these faults may underestimate the level of hazard in the regions where faults with long recurrence interval pass through.

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