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REGIONAL PROBABILISTIC SEISMIC HAZARD ANALYSES USING GEOLOGIC DATA

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SUMMARY

Probabilistic earthquake hazard assessment due to strong ground shaking are usually based on historical seismicity. Detailed geologic data can be integrated with seismicity data to define more accurately the overall hazard and to evaluate local variations in the hazard, based on proximity to the active faults and the differences in the rate of activity of the faults. The geologic factors that have the greatest impact on the computed hazard are the seismic source model, the form of the fault-specific magnitude distribution ,and the frequency of large-magnitude earthquakes. This paper shows the sensitivity of seismic hazard assessments to variations in recurrence models and parameters that incorporate fault slip rates. This procedure is used to estimate seismicity in Azarbayjan region in the north-west of Iran. The estimates of the seismicity resulting from these slip rates are consistent with historical records of earthquake occurrence in the region. For individual faults (e.g. North Tabriz fault zone) the seismicity estimated from slip rates may differ from the historical rates of seismicity by a factor of two or more.

INTRODUCTION

The area under consideration in adaptation with geographical maps is located the point with co-ordinates of latitude 38.7 N and longitude 46.7E with extension of $2^{o} \times 2^{o}$ in the north of Azarbijan province in Iran.

The aim of selection the centre of the area is that it must be located next to the place of construction related to copper mine in district of copper profile in Songon. In this region which is a part of Gharah-Bagh mountains, small joints and ruptures have splitted its stones.

In rose diagram (1) the general procedure of these local faulting is observed (Khazaii and Ghoreishi, 1996). Topography around the mine with vertical exaggeration is shown in Figure 2 (Eslami and Tavakoli, 1998). Tectonical location of plan is restricted from south and south-west to the main thrust of Zagros, from east and north-east to Khazar fault and Astara, and from north to compressional faults of Caucasus and from north-west and west to faults of north and east Anatolia and Borjoomi-Kazbak fault (Fig.3, Philip et al 1996).

Examples of fault plane solution of earthquakes in east of Turkey, Caucasus and north-west of Iran are the same as Fig.4 (Philip et al. 1989). Examples of slip vectors of region is shown in Fig.5 (Jackson, 1996).

ACTIVE FAULTS OF PLAN AREA

Generally the estimation of average recurrence of strong earthquakes is not satisfactorily possible because of shortage of sampling and variation in occurrence specially disturbance of critical phenomenon of earthquake. However, from variations in return period of great earthquake in north-west of Iran, Berberian (1997) has believed that in this region, the earthquakes occur along specific faults like north Tabriz fault which in short interval, clusters of earthquakes and in long interval, quiescence and large return periods can be observed.

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Revision of return periods along some faults shows that pattern of location and time distribution of earthquake occurrence with confusional scenarios, is much more complicated to obey a fix form (Eslami, 1992).

The small distances between active faults with different focal mechanisms and trends and their interactions with each other as secondary faulting may increase the hazards of large events in a short interval. Also the possibility of simultaneous rupture of the whole length of active faults which composed of several segments, increases the intrinsic magnitudes of future earthquakes in region as faulting in some places. Such acceptance in possibility domain seems more satisfactory than accepting a certain pattern for north west of Iran. Anyway, the most important feature of seismogenic sources are active faults. In this case, the complete information of their displacement and activity is needed.. A general description for identification of active faults has not been suggested yet.

From geological point of view, active fault is a tectonical rupture that has been active in quaternary era and will possibly be active in future. From engineering point of view, active fault is a fault that has had some displacements since later Holocene epoch (ten thousands years ago) by now and will possibly have activity in future hundred years (Vang-timal 1994).

The following documents are useful in identification of an active fault (Berberian et al 1985):

- Historical events in some parts of fault.

- Faulting in later quaternary sediments.

- Numerous micro earthquakes that can be recorded by seismic networks.

- Tectonical adaptation of a fault with an active well-known fault.

Considering the above comments, investigation the active faults of an area is one of the most fundamental steps in evaluation of seismic hazards in a site. Weights for evaluating active faults are as follows:

Sense of slip dip, maximum depth, total length, rupture length, maximum displacement, average displacement, historical event with maximum magnitude and slip rate. It is evident that access to all these weights needs some researches in different aspects and this study is only based on current weights.

METHODOLOGY

Data is processed in three cases with different uncertainties by method of Kijko-Sellevoul (1992), (Figures 6 and 7). In this calculation non-linear behaviour of large earthquakes that have doubtful annual rate is significant with fluctuation of curve slope, while up to magnitude seven, linear behaviour is acceptable. Such a result considering inconsistency of data with characteristic earthquake model (Showartz and Coppersmith, 1984) causes to evaluate a linear trend for earthquakes up to 7 by wichert (1995) and consider larger earthquakes based on local tectonic and individual specifications of faults in non-linear interval.

CONCLUSION

In the interim of Seismic hazard assessment for Azarbayejan region, we found out that very large earthquakes occur in long time spans and out of the time period of our sampling catalogue. the rate of such large events, is determined by trenching and identifying the buried faults recently, which this method have some uncertainties itself associated with the related degree of precision in determining the age of faults. Relaying upon definition of MCE or other magnitude scales, have not been successful in clearing up the ambiguities in this respect. It was also found out that classifying the earthquakes into historical and instrumental recording periods and introducing their uncertainties by Kijko and Sellevoll (1992) and assessing them together, is also inhomogeneous combination. The return period and annual rate estimate of large events will become a matter of doubt due to these defects. We believe that only in a consorted interval including the threshold magnitude to maximum magnitude, related to the present time regime of region, the usage of double truncated Gutenberg Richter relation, or the appropriate likelihood method along with the statistical deductions, will be useful. Extending this approach to the points out of the Mo-Mmas interval would be possible only by geological and tectonic analyses and investigations. This would be of chaotic behaviour with ambiguity and although some researchers (Youngs and Coppersmith, 1985) assigned this behaviour to individual faults under the name of characteristic earthquakes, the doubt and fluctuation about this will remain always.

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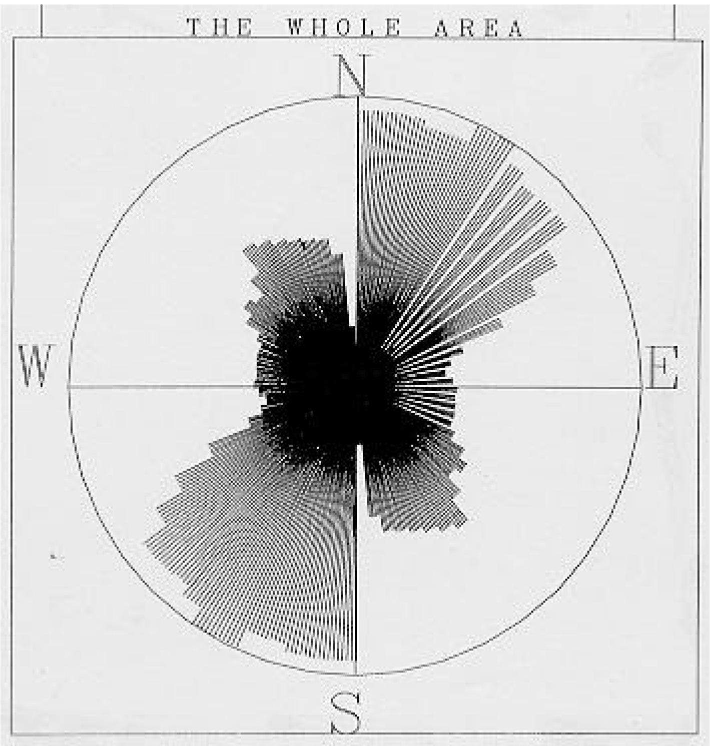

Fig. 1 – Rose diagram of faults in plan area (after Khazaii and Ghoreishi, 1996)

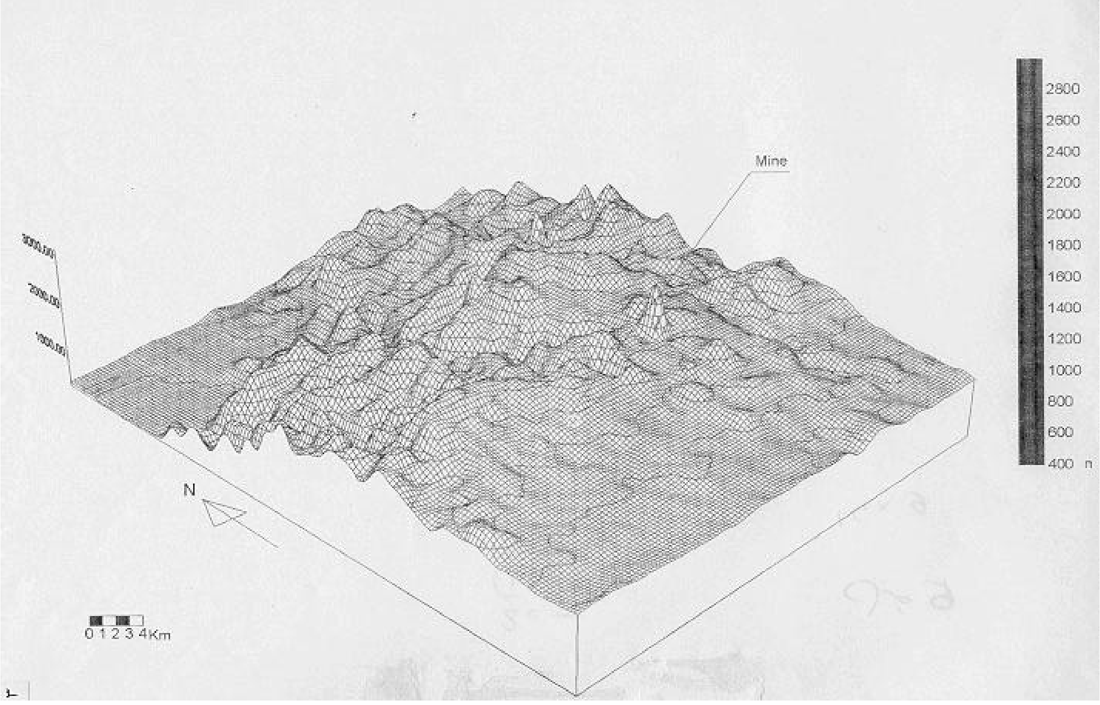

Fig.2 – Topographical map of the studied area and mine location

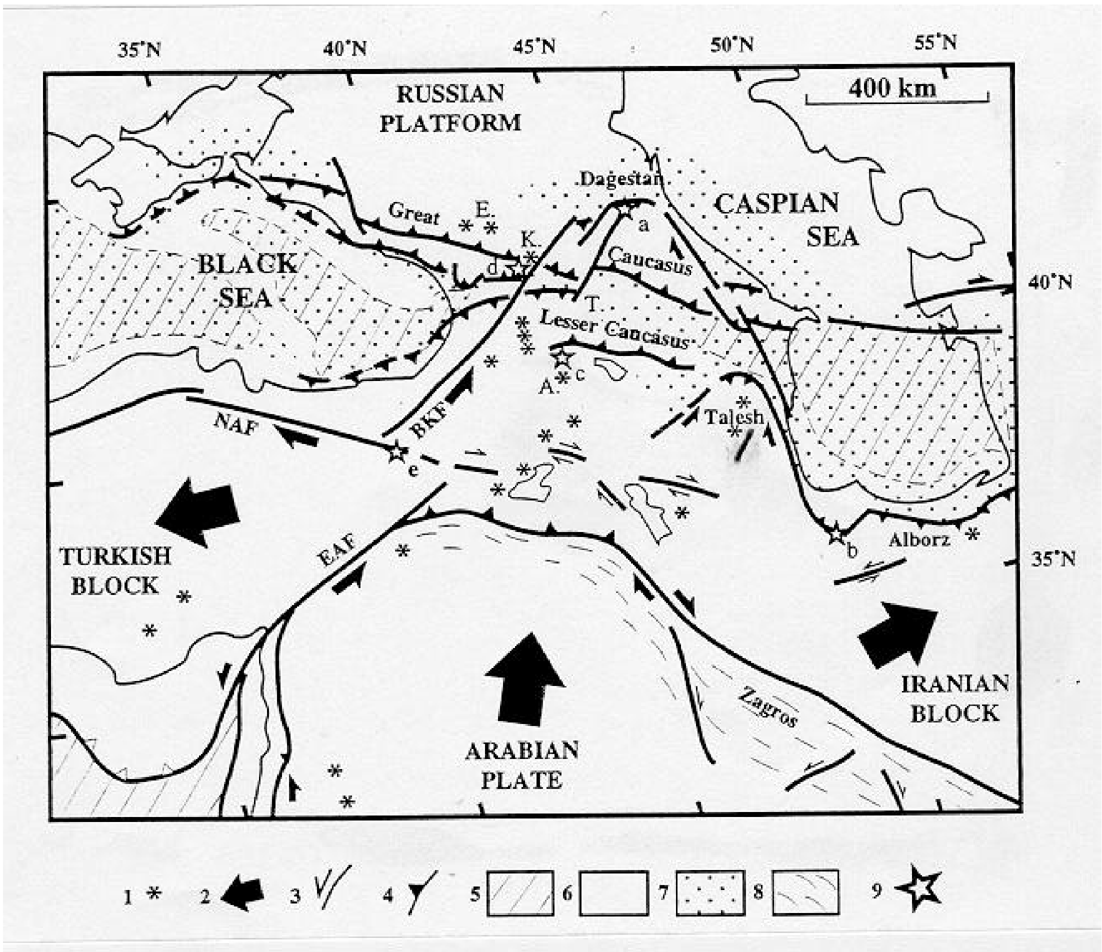

Fig.3 – Tectonical situation of plan area (After Philip et al. 1996)

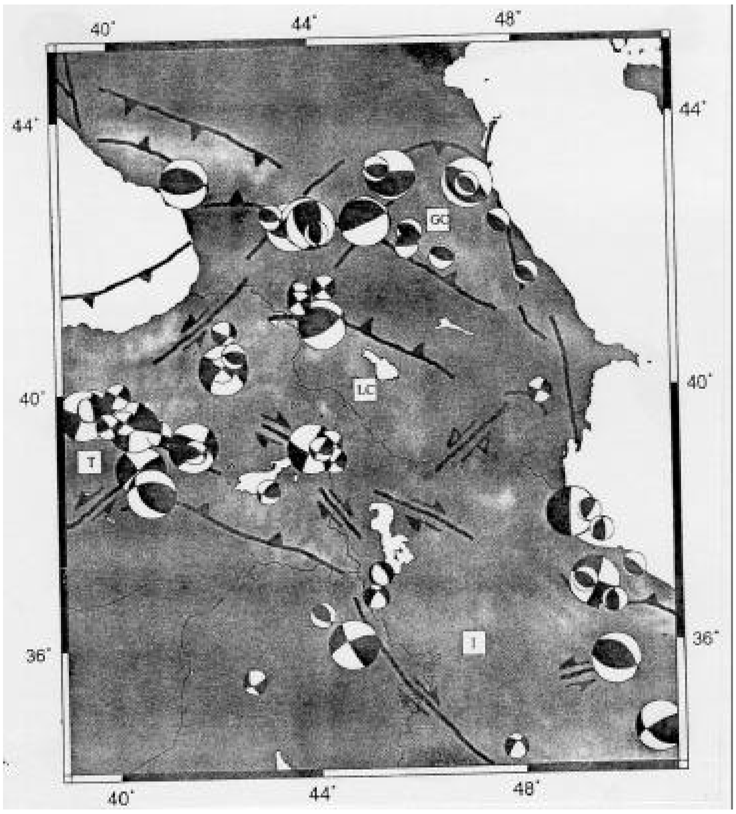

Fig. 4 – Fault plane solutions , approximate location of great faults by Philip et al. 1989

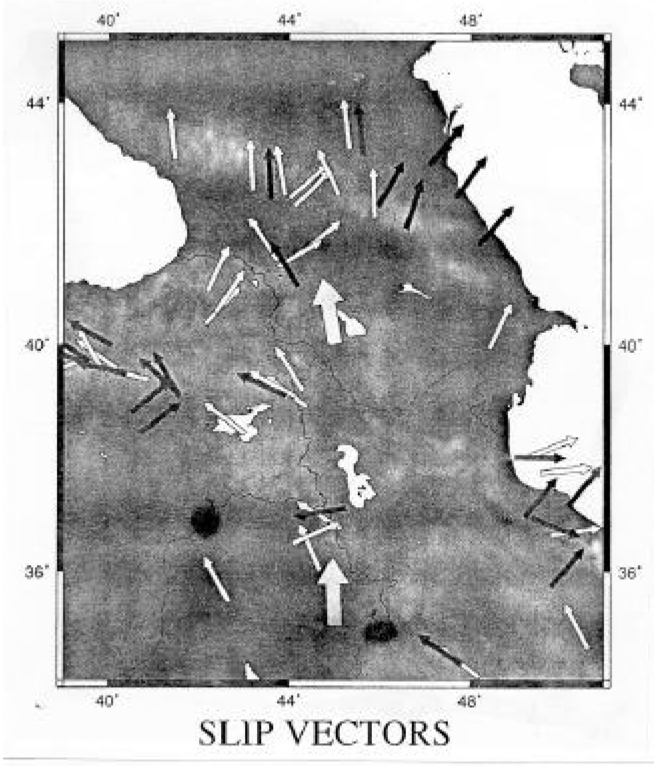

Fig. 5 - Representation of slip vectors for located earthquakes in the region (dark arrows are rupture surface and the white arrows are slip vectors).

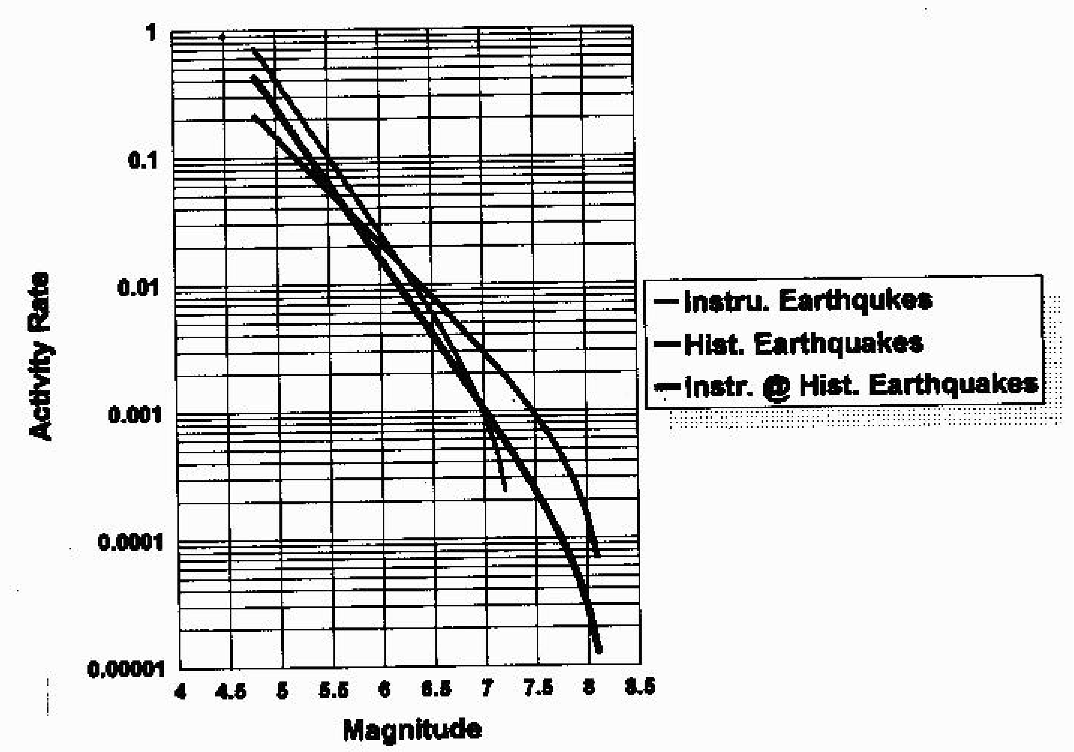

Fig. 6- Relationship between magnitude and activity rate for historical and instrumental earthquakes

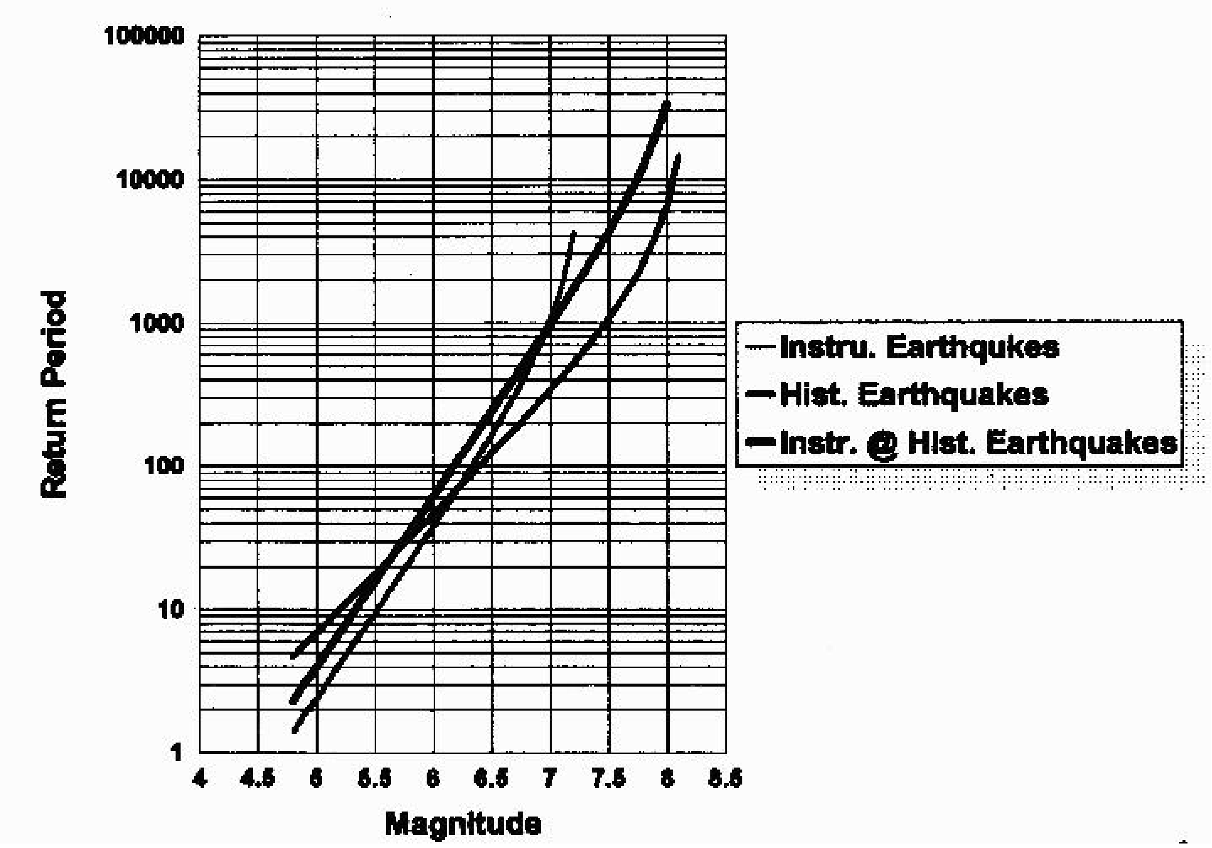

Fig. 7 – Relationship between magnitude and return period