INVESTIGATION OF THE CONTEMPORARY STRESS STATE IN CENTRAL ZAGROS

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ABSTRACT

Among the present active belt, the Zagros mountain fold and thrust belt located in SW Iran, is one of the most seismically active regions in the world. It results from the collision of the Arabian plate with continental blocks of Central Iran. The studied area extend between 50 to 54E, characterizing by N-S-trending right laterally strike slip faults such as Kazerun, Kareh-Bas, Sabzpushan and Razak-Sarvestan.

The main purpose of present study is to find the state and direction of contemporary stress investigated by using inversion methodology. Furthermore specification mechanism of faults that have different direction and trend based on stress state near these faults. The present – day state of stress responsible for active faulting in central Zagros determined by inversion of focal mechanism from moderate to large ($4.5 \leq M \leq 7$) earthquakes. Furthermore, in this study we determined the stress tensor for local micro earthquakes focal mechanisms that have solved by first polarity of P wave (Tatar et.al, 2003).This method for inversion proposed by Carey- Gailhardis and Mercier (1987).

According to our data and deduced results, in central Zagros, the Arabia-Eurasia convergence is taking up by strike-slip faulting along NEE trending left lateral and NWW trending right lateral faults, as well as reverse to oblique-slip reverse faulting along NW trending faults. The direction of maximum shear stress (σ_1) vary about 35° of the northwest to southeast in central Zagros and about tectonic regimes we can told that compression tectonic regimes govern to over Zagros and strike slip faults that existed in that, regionally controls this regimes.

INTRODUCTION

In the domain of southwestern Iran that named Zagros, geomorphic and many faults existed having different trend. The Zagros Mountain fold- and trust belt that located between Arabia plate and Eurasia is one of seismically region in the world. In the past decade after increasing seismic station in Iran (BB station of IIEES and IRSC), furthermore computed focal mechanisms are increased (Irsc of Tehran University by waveform modeling) and about 67 focal mechanism solutions exist. So that acknowledges about stress state and direction of it very important, furthermore by solving stress tensor we will arrived to tectonic regimes. We show in Figure1 seismicity with focal mechanism that solved by CMT for earthquake greater than 5.

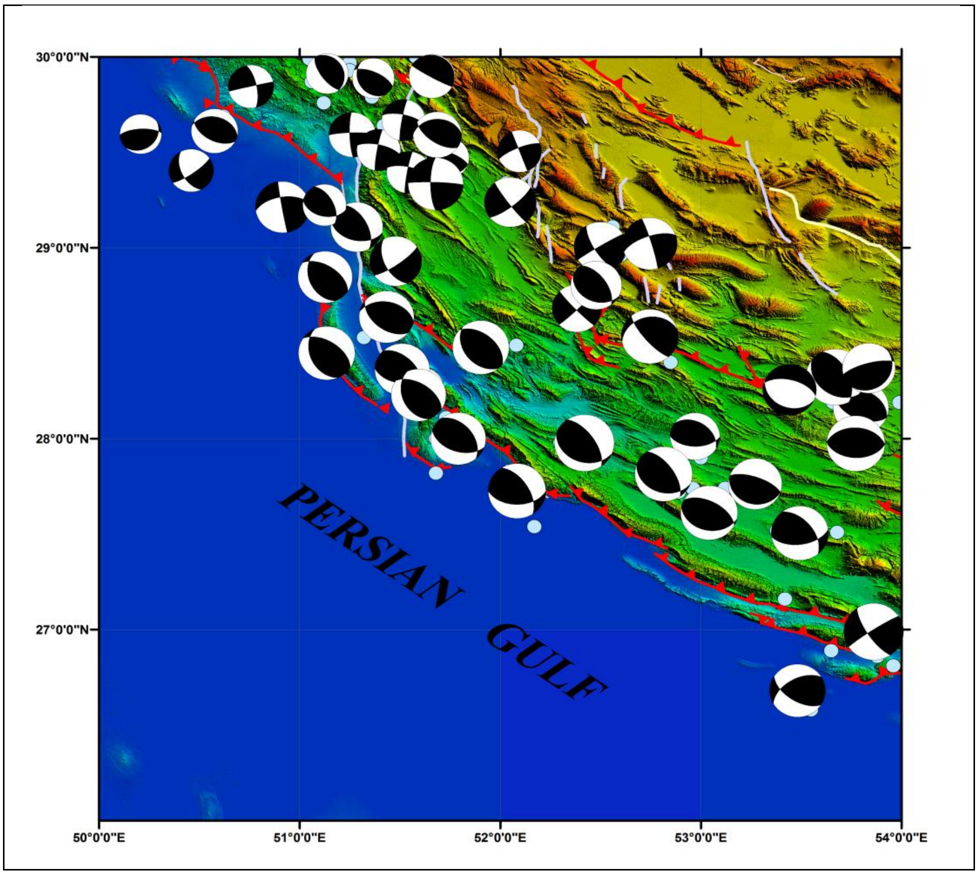

Figure1. Focal mechanism of Harvard university catalog (CMT) from the period between 1893 and 2013.

Based on this focal mechanism with other focal mechanism by waveform modeling (IRSC) and polarity of P wave (Tatar et al , 2003), we can had a well estimate of present- day stress state in this region.

INVERSION OF EARTHQUAKE FOCAL MECHANISM DATA

The present-day state of stress responsible for active fault in central Zagros was determined by inversion of focal mechanism from moderate to large ($4.5 \leq M \leq 7$) and micro earthquake focal mechanism that implicated above using the method proposed by Carey-Gailhardis and Mercier (1987). In this method computation of stress state from populations of focal mechanisms require to knowledge of the seismic slip vectors and consequently the selection of the preferred seismic fault plane from each of nodal planes. The selection can be made directly from the observation of coseismic rupture as well as the distributions of the aftershock sequence, or by inverse computation. In the last alternative, the selection is possible because only one of the two slip vectors of focal mechanism is the seismic fault slip vector and in agreement with the principal stress axes. (Carey - Gailhardis and Mercier, 1987, 1992) defined using the dihedral method (Angelier and Mechler, 1977; Carey - Gailhardis and Vergely, 1992) before the inversion of focal mechanisms. In this study we used the computation method mentioned above to select seismic fault of each focal mechanism.

Inversion of fault kinematics is based on several basic assumptions (Mercier et al., 1991; Carey-Gailhardis and Mercier, 1992): (1) the slip responsible for the striation occurs on each fault plane in the direction and sense of maximum shear stress resolved on the fault plane, (2) the slips on the fault planes is independent, (3) the faulted materials is homogeneous and (4) fault displacement is small with respect of faults length and no ductile deformation and rotation of the fault plane has occurred during the faulting.

The stress ratio, $R = \sigma_2 - \sigma_1 / \sigma_3 - \sigma_1$ describes the relative stress magnitudes of calculated mean deviatoric stress tensors. The signification of stress ratio in interpreting inversion method is important. In this study we show stress regimes in term of R values in LP diagrams. This diagram constitute of two axis, vertical axis is decadic logarithm of the $\frac{\sigma_2}{\sigma_3}$ ($\frac{\sigma_2}{\sigma_1}$ for transtensional tectonic regimes) and horizontal axis is R value that range from 0 to 1.

RESULT OF STRESS STATE

Based on P axis of focal mechanism and geology features such as faults and folds in central Zagros we subdivided this region to five zones. For this study we analysis 67 focal mechanism that solved by CMT and 35 focal mechanisms have solved by IRSC and 69 micro earthquake focal solution by Tatar (2003). However, 13 focal are not reliable enough to included in the computed inversions. These are mainly aftershocks with low magnitude or ill-defined focal mechanisms. Following we explain results that deduced from all focal mechanisms by inversion method. Results of earthquake slip datum inversions are given in table 1 and shown with stereo plot in figure 2 for each zone.

Table1. The result of stress tensors deduced from inversion of earthquake focal mechanisms data characterizing the present- day stress regime in central Zagros.

Zone	σ1			σ2			σ3			R	Rm
	trend	**pl**	**mag**	**trend**	**pl**	**mag**	**trend**	**pl**	**mag**	____	___
1	230	2	-1.07	126	83	0.19	320	7	0.87	0.646	**SS**
2	40	5	-0.78	131	3	0.03	250	84	0.75	0.528	**C**
3	198	5	-0.79	28	85	0.01	288	1	0.76	0.511	**SS**
4	25	7	-0.81	294	8	0.11	154	80	0.7	0.612	**C**
5	16	1	-0.74	106	3	0.04	265	87	0.7	0.538	**C**
4+5	20	3	-0.76	110	3	0.05	247	86	0.7	0.556	**C**
IRSC(2)	54	0.1	-0.87	324	11	0.17	147	79	0.69	0.667	**C**
IRSC(2)+2	46	3	-0.81	316	7	0.07	159	82	0.74	0.569	**C**
GHIR	214	10	-1.02	42	80	0.23	304	1	0.79	0.692	**SS**
	20	2	-0.83	110	1	0.2	236	87	0.62	0.712	**C**

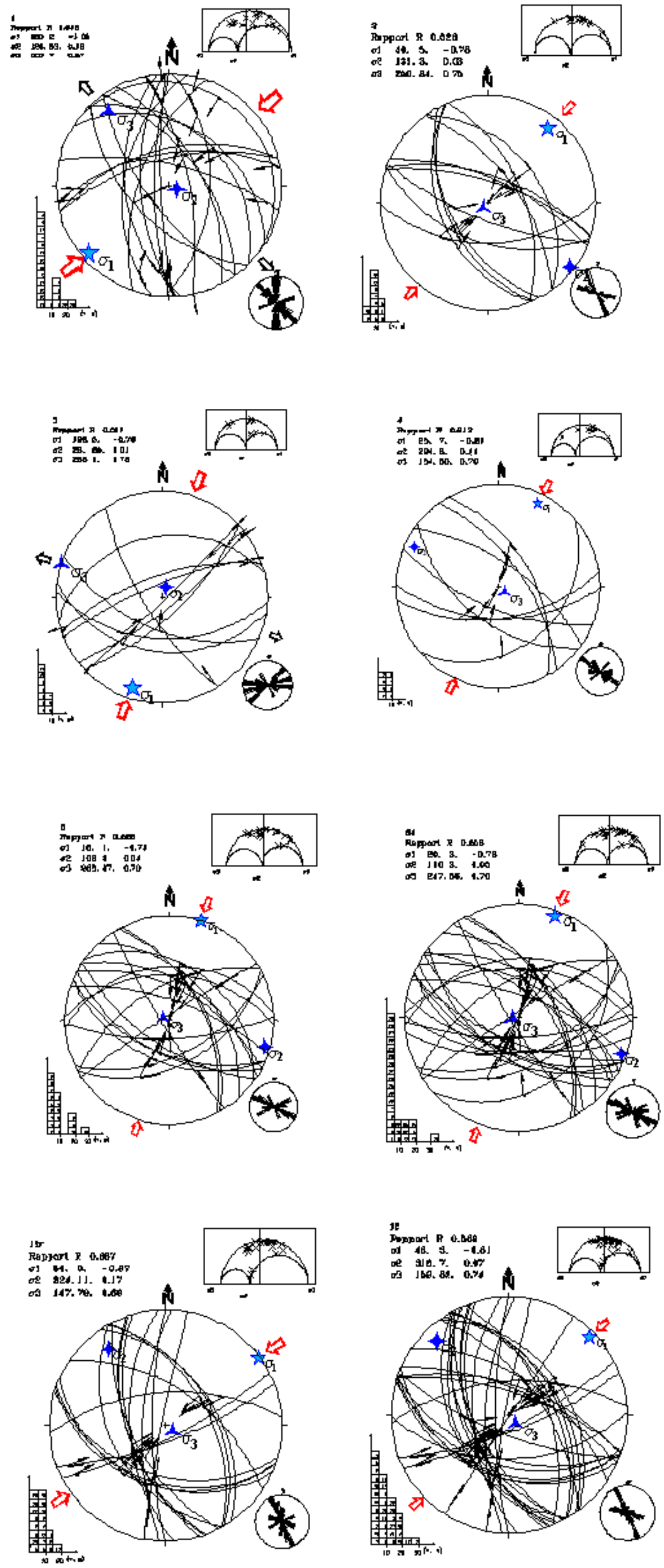

Figure2. Result deduced from focal mechanism data using inversion method in 5 regions. The red arrow show direction of maximum stress, histograms show distribution of deviation angles between the measured and calculated slip vectors. Number correspond to the label related to focal is used in inversion. Mohr circle show shear to normal stress ratio that placed in right top each pictures. The rose diagrams that located in low and left side show trending of fault planes.

The focal mechanisms in GHIR region also divided two clusters. One has compressional regimes and other one has strike-slip regimes. The picture 3 shows these results with two constant stress tensors.

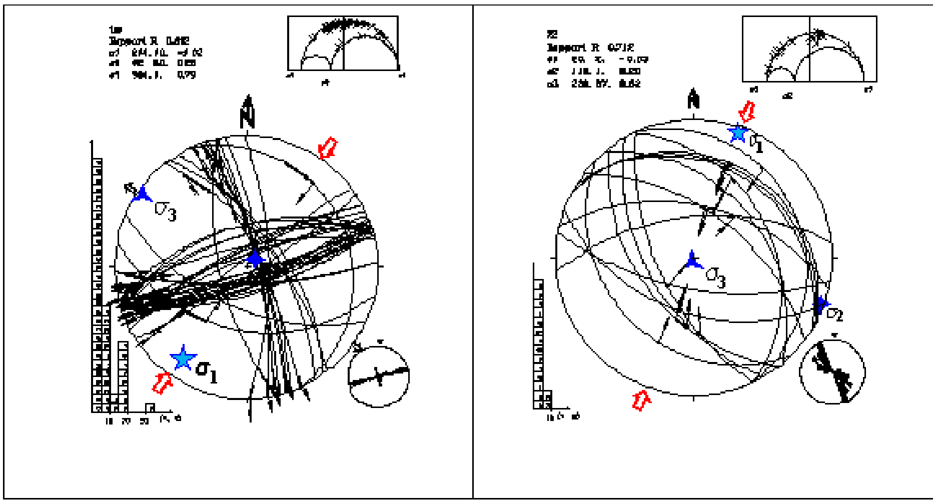

Figure3. Stress tensors draw conclusions for GHIR region that divided two clusters. The left one show strike-slip regime because σ_2 is vertical axis and right side showing compressional regime.

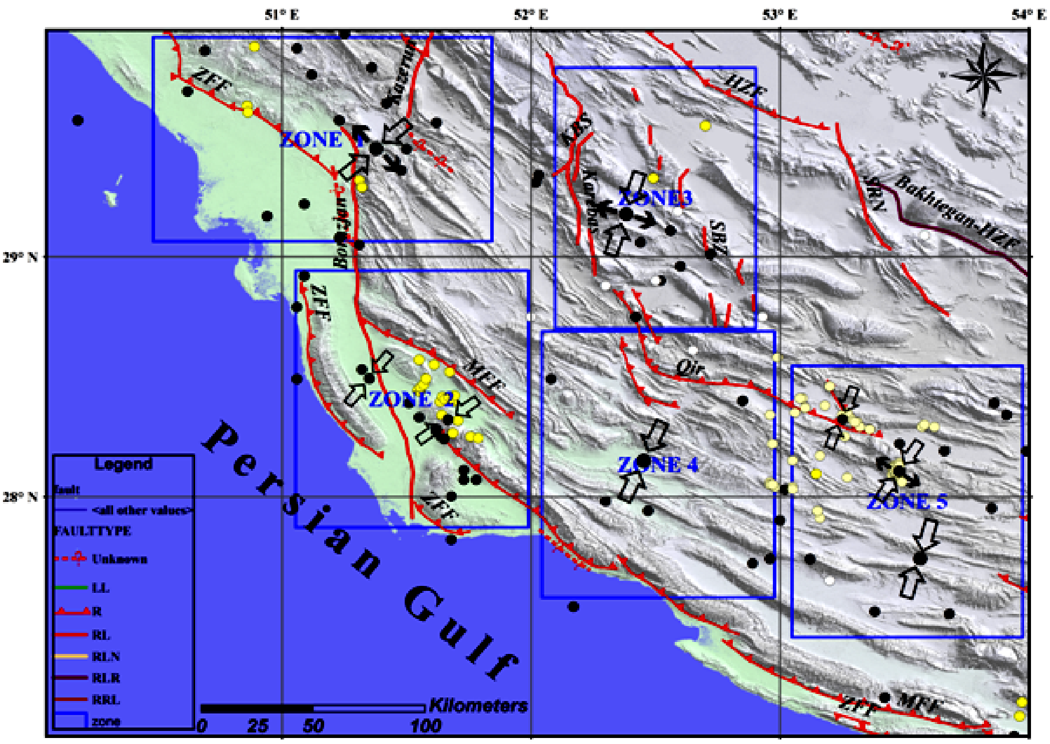

Fig4. Map of the present- day stress state deduced from inversion of earthquake focal mechanisms data in central Zagros. In this study, we subdivided central Zagros to five zones based on geology structure and P axes of focal mechanisms.

In the end of this study, results show that the direction of maximum shear stress (σ_1) vary about 35° of the northwest to southeast in central Zagros (table 1, figure 4), furthermore trending maximum stress changes of NE on northwestern Zagros to N on Southeastern it. Also LP diagrams illustrated many of results are stable with compressional tectonic regime and only three of data locally show transpressional (figure 5).

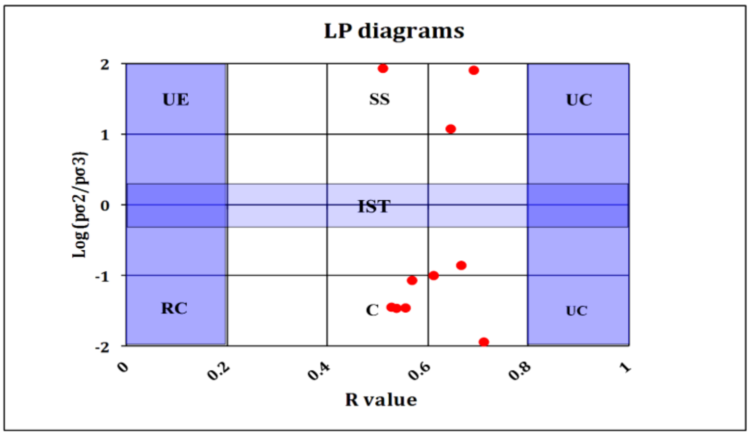

Figure5. The LP diagram that shows tectonic regime based on R value. Vertical axis is decadic logarithm of $\frac{\sigma_2}{\sigma_3}$ and horizontal axis is R value.

CONCLUSION

The variation of maximum stress direction is about 35° of the northwest to southeast in the central Zagros. we can told that compression tectonic regimes govern to over Zagros and strike slip faults that existed in that, regionally controls this regime.

The NW-SE trending faults showing thrust faulting with a small right laterally horizontal component. The second faulting trend comprises the N-S strike-slip, which displaces the major trends right laterally. Locally the E-W-trending faults are strike-slip faulting with minor extensional component. In a regional scale the E-W-trending faults show a left laterally strike-slip mechanism with a compressional component.

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