COMPOSITE FOCAL MECHANISM OF MICROEARTHQUAKE PATTERNS IN NORTH CENTRAL IRAQ.

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الخلاصة:

اظهرت حلول مستوى الصدع لهزات ارضية كبيرة على امتداد نطاق التصادم القاري زاكروس- طوروس تصدعا "معكوساً" بزاوية عالية موزعاً على امتداد النطاق المطوي.

اعطت مراقبة الهزات الدقيقة في منطقة شمال العراق وخلال الفترة ١٩٨٩-١٩٩٠، انماط توزيع خطية للهزات الدقيقة. وظفت هذه المعلومات لانجاز حلول مركبة لمستوى الصدع في تلك المنطقة.

اعطت حلول مستوى الصدع المركبة على امتداد نمطين لتوزيع الهزات الدقيقة تصدعاً "معكوساً" يكون موازي تقريباً الى الاتجاهات الزلزالية هذه النتائج تسلط الضوء على الظروف التكتونية ومستوى المخاطر الزلزالية في تلك المنطقة من شمال العراق. تكون هذه الحلول منسجمة مع دراسات حلول مستوى الصدع لهزات كبيرة المقدار الزلزالي مع مواقع بؤرية قريبة وحول منطقة الدراسة.

ABSTRACT:

fault plane solutions for large events along the Zagros- Tauros continental collision zone shows high angle reverse faulting distributed along the folded belt.

Recent microearthquakes monitoring in north central Iraq during the period 1989-1990 gave linear microearthquake patterns. This data was employed to carry out the first time a Composite Fault Plane Solution (CFPS) in the area.

The CFPS for the p - wave arrivals from the vertical component , along two microearthquake trends gave reverse faulting solutions, nearly parallel to the seismic trends. These results sheds light on the tectonic conditions and seismic risk levels in north central Iraq. They are consistent with previous FPS studies using large magnitude earthquakes with epicentral locations in and around the study area.

INTRODUCTION:

Earthquake are the result of sudden release of tectonic stresses within the lithosphere . Fault plane solution allows us to determine the mode of change in the earth at specific time and locations. The accumulation of fault plane solutions, reveals the kinematic behavior of major seismic zones.

The north and northeastern parts of Iraq lie within the Zagros-Tauros Neogene continental collision zone. This zone is roughly bounded by the main Zagros thrust fault to the NE, and the Zagros folds belt about 250 kms farther west, and the Tiblisi suture zone and the Tauros folded belt to the north and northwest.

The investigated area lies on the edge of the Zagros folds. The thick sedimentary cover of the Zagors, (6-12kms.) are predominately platform carbonates deposited on the NE flanks of the Arabian Pre-Cambrian basement (Fig.1).

The Zagros folds are characterized by the lack of mapped faults and absence of faults breaks during the occurrence of large earthquakes. This is attributed to the thick evaporates that acts as a decoupling factor. The folding intensity decrease towards the Mesopotamian foredeep. The Zagros mountain belt is typified by high angle reverse faults(1).

Alsinawi and Ghalib(2) reported fault plane solutions for epicenters located in northern Iraq.

The solutions revealed reverse faulting mechanism.

Alsinawi and Issa(3) complied fifteen fault plane solutions for events located in and around NE Iraqi territory.Most solutions along the Zagros folded belt gave high angle thrust faulting mechanism along NW-SE direction; parallel to the structure of the Zagros- Tauros belt, (Fig. 5).

This investigation marks the first composite fault plane solution attempt based on micro- earthquake data in Iraq.

METHODOLOGY:

Fault plane solutions were pioneered by (4,5,6). The methodology for determining FPS using body and surface waves data has been described by (7, 8, 9).

Composite Fault Plane Solutions (CFPS) have been used successfully by many investigators (e.g.10,11) to decipher the details of slip patterns in complex areas, small earthquakes which are though to result from localized stress patterns and zones of weakness; one expects their focal mechanisms to correlate with each other only in a statistical way(12).

Because of the difficulty in applying conventional (FPS) for the study area; simply because of the long return periods of (M≥5) earthquakes in the area, it was decided to apply the (CFPS) technique. The first motion from many microearthquakes are complied in one focal sphere using few seismographic stations.

The p-wave first arrivals and their corresponding direction of motion are read from the Z-component seismograms.

The position of a given event on the surface of the focal sphere is determined by (α) the azimuthal angle and (β) the take- off angle. α is computed from the coordinates of the hypocenter and of the given station. ß is determined in the course of computing the travel time derivatives as given by(13).

The focal depth of the earthquakes together with the uncertainity of the crustal structure may affect the take- off angle(ß)(14). ß was determined using travel time derivatives, according to the crustal structure of the studied area as given by(15)..

Most events were located with a fixed focal depth of ten kilometers. This together with the uncertaininity of the crustal structure, may affect the value of (ß) by 10-20 degrees.

DATA ACQUISITION:

Microearthquakes recording in a rectangular array using short period, vertical component seismic systems was carried out in the area shown in Fig.(1), by (16). For a total recording period of 69 days between (December 1989- April 1990), more than 500 events were recorded. From more than (500) events that were recorded by the network, 155 events were selected for detailed study. Only records having high signal to noise ratio, with sharp first arrivals were chosen. To reduce the effect of scatter on the interpretation, the seismograms were reread, and the final number of events chosen was (85) events showing optimal quality for (CFPS), Fig.2.

DATA ANALYSIS:

Well defined linear seismicity trends in the studied area were noticed. The seismcity map of area, Fig.2, was used to delineate possible linear seismicity trends and segments. The seismic zones given in Fig.3, represent an initial attempt to define the seismicity pattern of the studied area.

The first motion of p-wave data were plotted in a lower hemisphere equal area projection, Fig.4. These plots were examined to check, if the data permits its separation into compressional and dilatational quadrants. The lack of such separation may be due to take- off angle (ß) in accuracies, or source zone definition.

The composite focal mechanism results are given in Fig.4. The data in (zone I) does not allow us to define nodal planes. This is attributed to the lack of points in the NE, NW and SE quadrants, and because of the station locations and coverage .

The zone II data were interpreted as a NE trending reverse fault, which generally agrees with the NE-SW seismicity trend.

The zone III data enabled us to constrain the solution to a nodal plane parallel to the NE trending seismicity pattern, suggesting a reverse fault. The zone IV data did not allow the drawing nodal planes.

The compiled data for the four zones are interpreted as a NW trending reverse faulting. The results are to be compared with published (FPS) given in Fig.5.

The data of zones II and III which gave definite reverse faulting, are consistent with the reverse faults that dominate the study area; regardless of the faulting trends that are shown in Fig.6.

These faults are assumed and ascertained (16).

The reverse faulting trends deduced from the (CFPS) carried out in this investigation are shown in Fig.6, together with the assumed fault rends.

These solutions help us to learn the geodynamic and tectonic conditions in the source region. The Zagros-Tauros collision continental zone is an area of much geophysical attention at the present.

The study area located in the high folded unstable shelf tectonic region of Iraq(17). The folding process that was initiated in the Pliocene time, was the last spisode in the Arabian- Iranian- Turkish continental convergence plates. The area is characterized by high and narrow anticlinal folds, with SW and S limbs, having intense dip and narrow synclinal folds which are associated with reverse faulting, as given in Fig.6.

This investigation should be viewed as an initial attempt to infer local and regional tectonics of north and north central Iraq.

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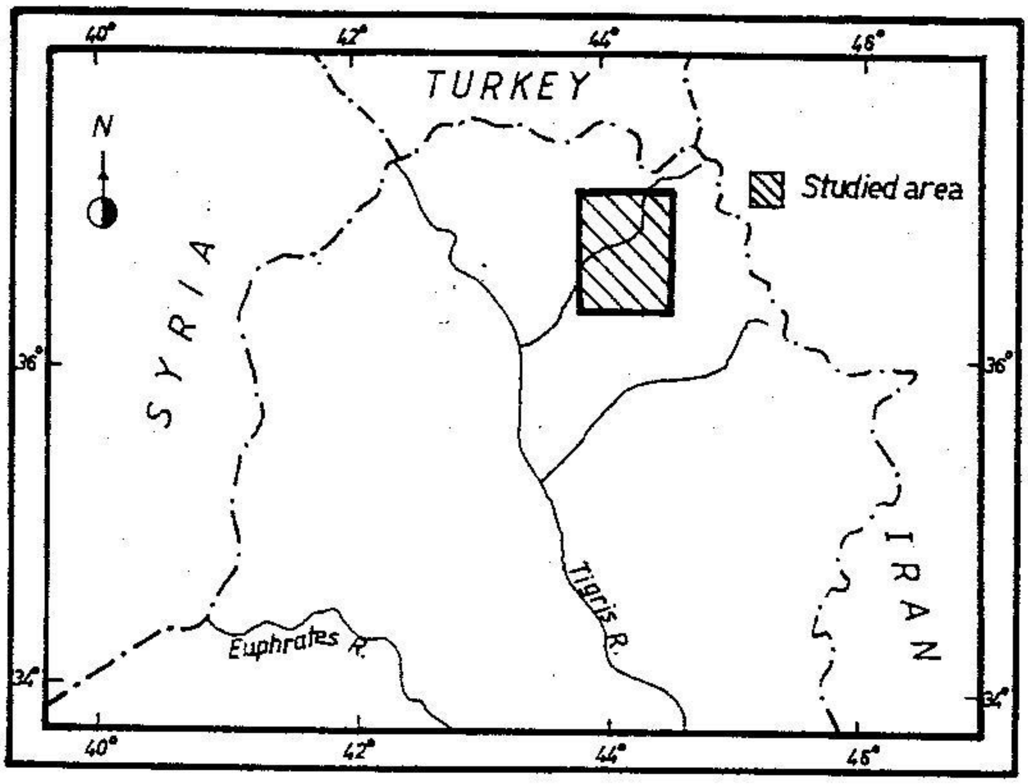

Fig. 1. Location map of the studied area .

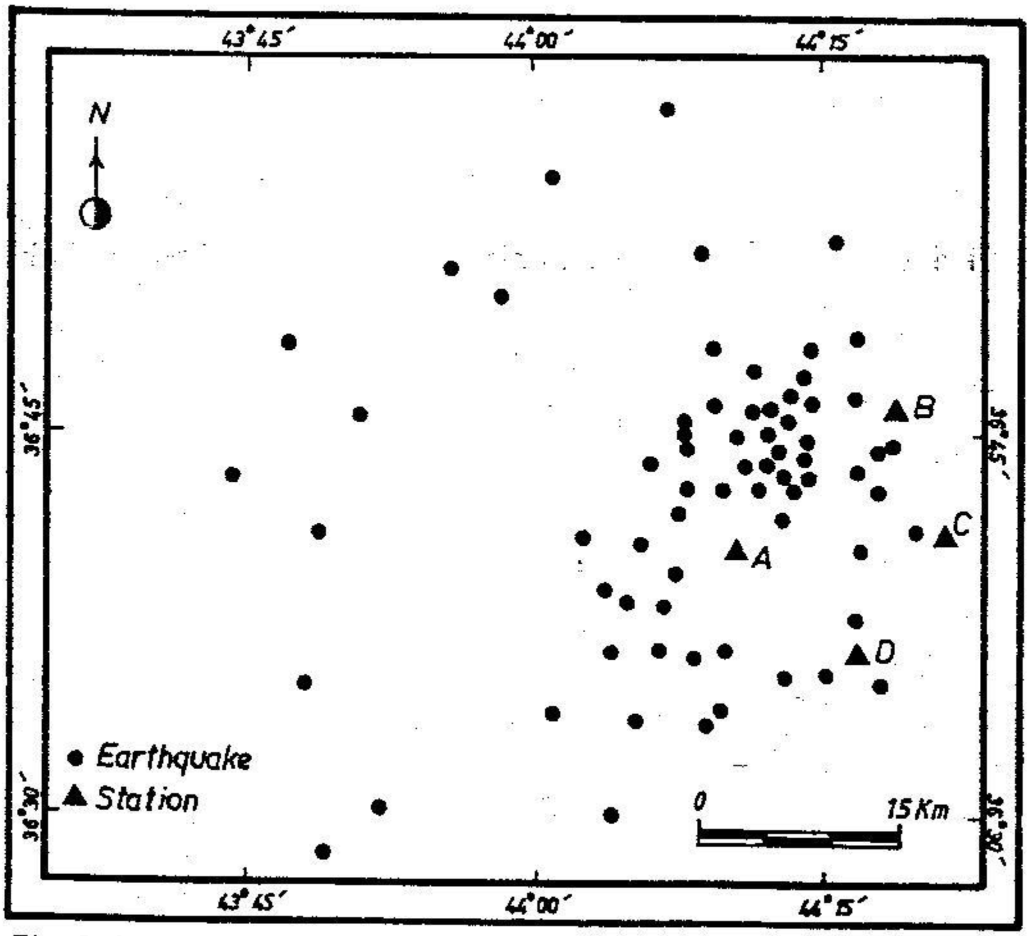

Fig. 2. Microearthquake locations (●) of the studied area and the seismograph stations (▲) Array (After Al-Hadethi, 1990).

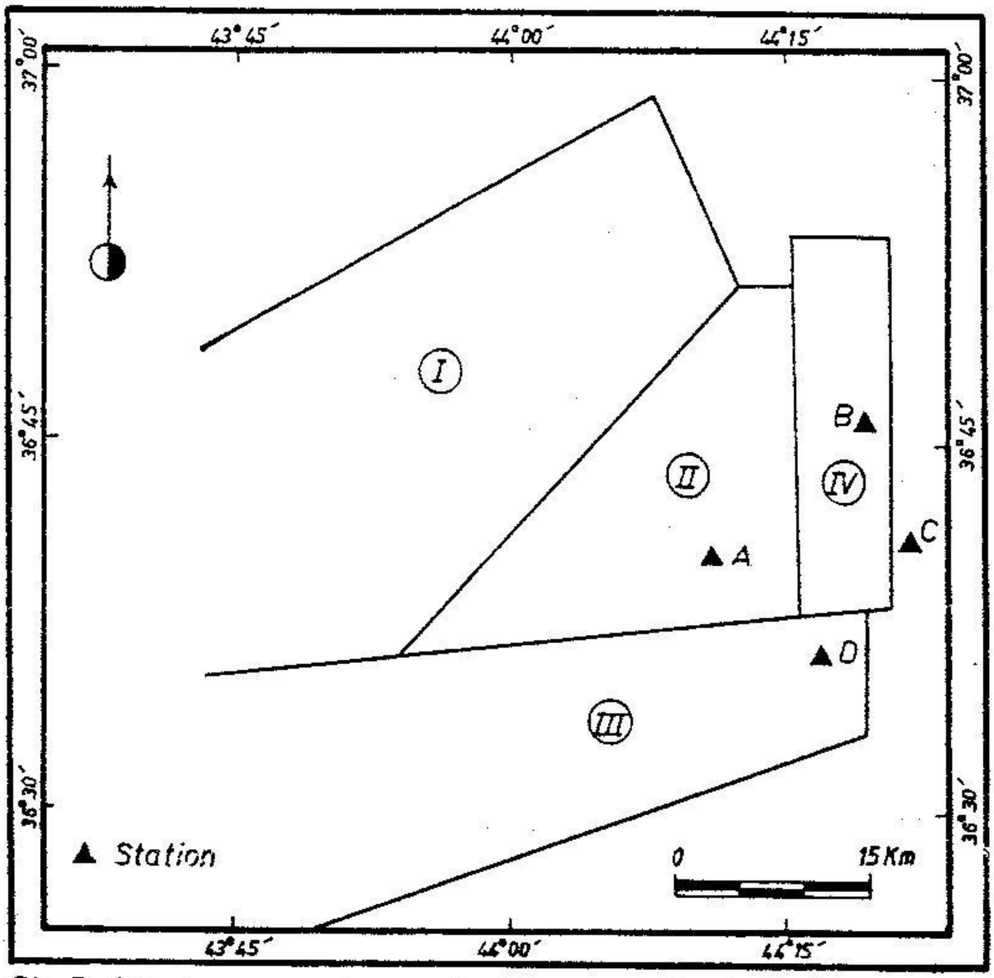

Fig. 3. Source zones chosen for the composite focal mechanism study.

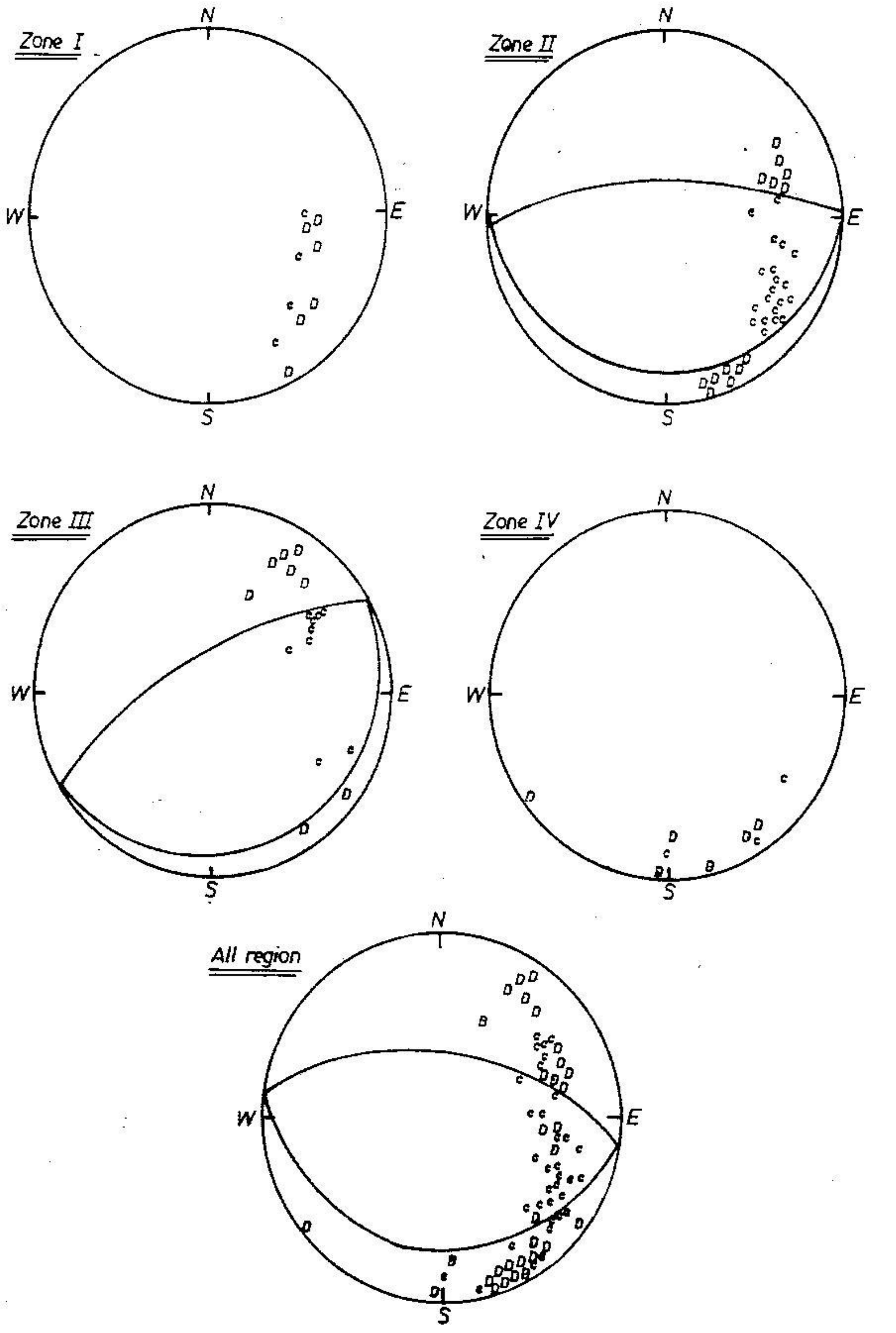

Fig.4. Composite focal mechanism for the source zones of figure 3. an equal area hemisphere was used. P-wave compressions are represented by (c), dilatations (D).

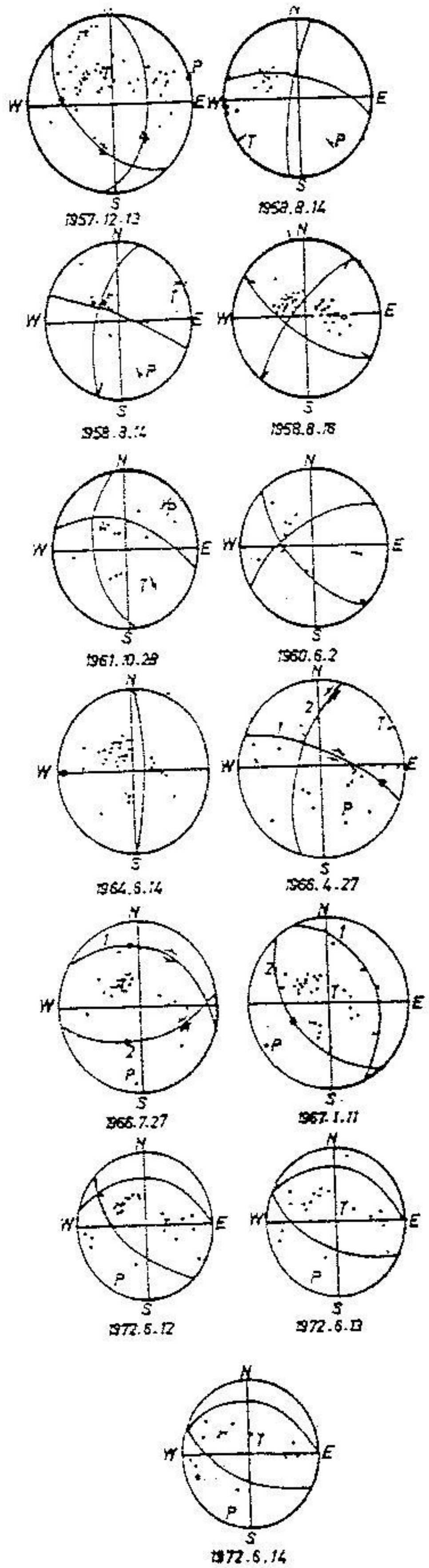

Fig. 5. Focal mechanism solution for earthquakes in Iraq and surrounding areas (lower hemisphere). • Compressional first motion P waves. • Dilatation first motion P waves. (Al-Sinawi and Issa, 1968) .

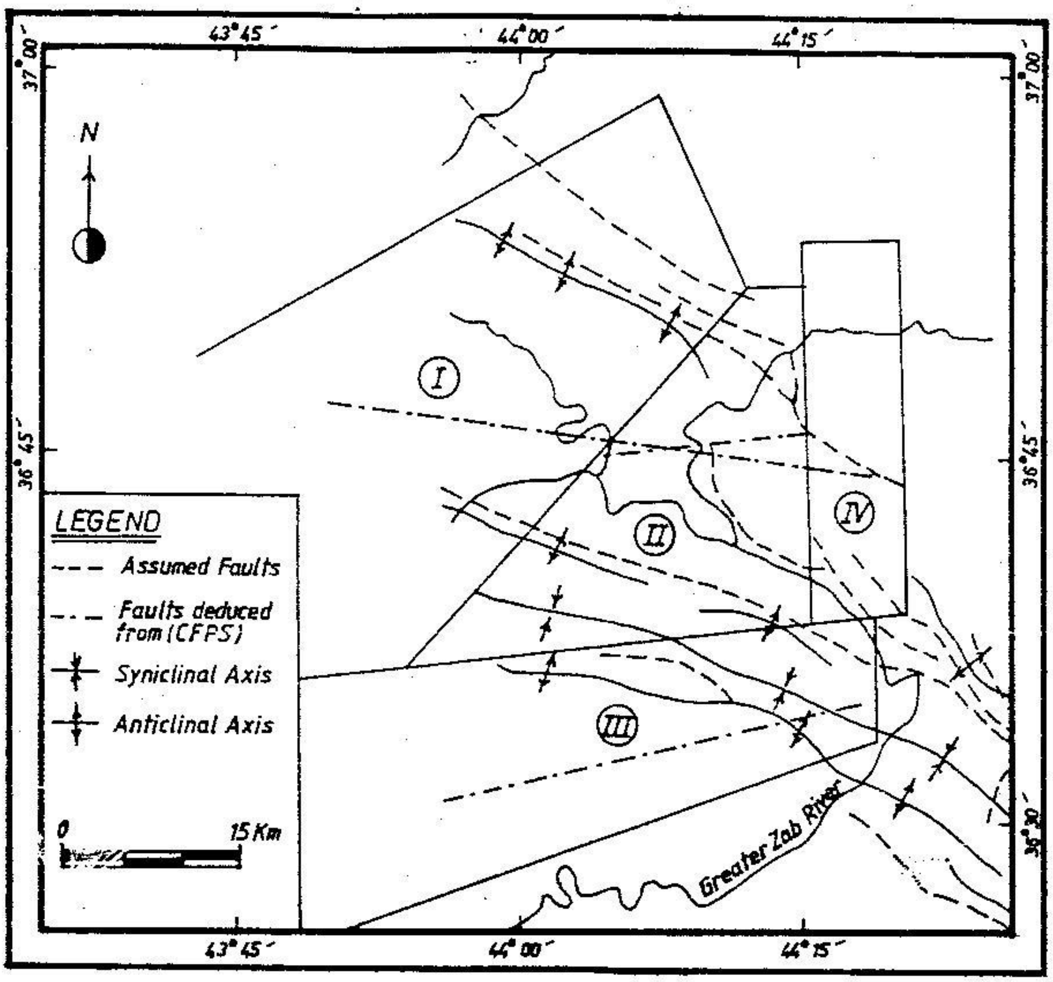

Fig. 6. Faulting trends, faults deduced from Composite Fault Plane Solutions (CFPS), and their relationship with the assumed faults in the studied area.