

# FOCAL MECHANISMS AND TECTONIC SEISMOLOGICAL EVIDENCES IN THE PESARO AND URBINO PROVINCE

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## Abstract

A focal mechanism study was carried out concerning seismic events occurred in the Pesaro and Urbino province from 1990 to 2002, using data recorded by the seismic network of the Istituto Nazionale di Geofisica e Vulcanologia. Analysis of these data showed that events can be considered in different sectors having similar seismological evidence. Focal mechanisms show that events belonging to the same sector have generally a well defined seismological evidence. In particular, it was possible to point out clearly an extensional stress regime in the axial sector and a compressional one in the sector from the high valley of the Marecchia river to the low valley of the Metauro river. The Adriatic off-shore sector shows not clear evidence of a nevertheless possible active compression; on the other hand no earthquake with magnitude greater than 5 occurred in the zone of northern Marche Adriatic off-shore in historical and recent times.

## 1. INTRODUCTION

In order to obtain a more detailed picture of seismological evidences in this zone, 14 new fault plane solutions of crustal events with  $2.8 \leq M \leq 4.2$  have been calculated, using data recorded by the national seismic network of the Istituto Nazionale di Geofisica e Vulcanologia (INGV) in the considered period 1990-2002.

A possible result of this study is the division of the Northern Marche region into three areas with different focal mechanism categories: the inner area of the Apennine belt, the Adriatic on-shore and the Adriatic off-shore. This work would be a contribution in order to update seismological evidences in the Northern Marche region. The aim is to add local information to the previous studies (e.g. *Frepoli & Amato, 1997; 2000*).

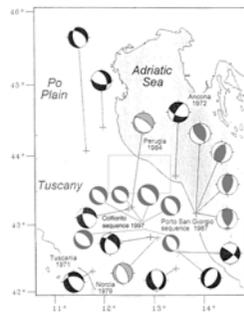


NATIONAL CENTRAL SEISMIC NETWORK (INGV seismic stations in Northern Marche)

## 2. PREVIOUS SEISMIC DATA

Many focal mechanisms of moderate events with magnitudes ranging between 4.0 and 5.8 have been determined for the Northern Apennines. The available fault-plane solutions of the period 1939-1980, calculated from arrival times and polarities read from seismic bulletins, are reported by *Gasparini et al. (1989)*: the best focal mechanisms are in the below figure.

This figure displays also two centroid moment tensor (CMT) solutions of *Norcia (1979)* and *Perugia (1984)* earthquakes and the focal mechanisms of four events of the *Porto San Giorgio* seismic sequence of July 1987 (*Riguzzi et al., 1989*). The two CMT solutions show an evident normal-fault regime along the portion of the Apennine belt, while the strike-slip solution of the *Ancona* earthquake (1972) shows a compressional axis (P) with ENE-WSW orientation (*Frepoli & Amato, 1997*).



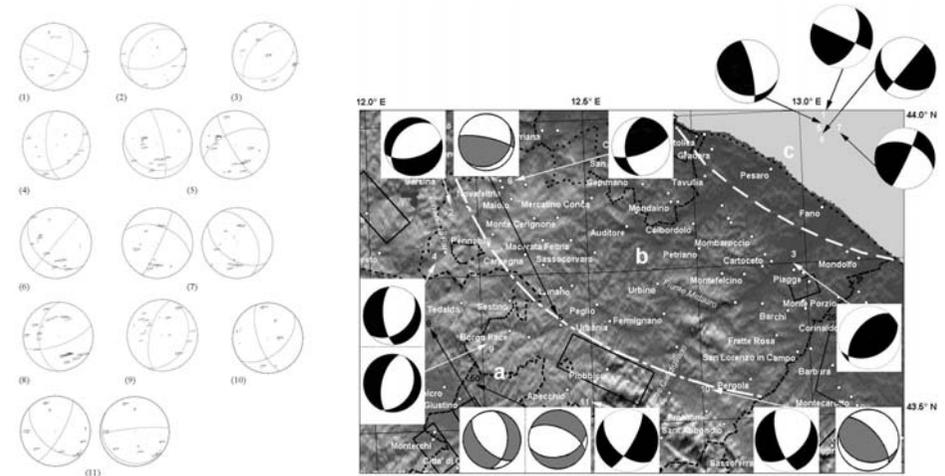
## 3. NEW FOCAL MECHANISMS

This classification is founded on the assumption that the earthquake focal mechanisms reflect the state of stress of the Northern Marche region, implying that the P- and T-axes, to a first approximation, correspond to the principal stress axes  $\sigma_1$  and  $\sigma_3$ , respectively.

Fault plane solutions are shown in the right figure for 11 events occurred in the Northern Marche from 1990 to 2002. The multiple solutions are due both to the low weight of some polarities and to the low azimuth coverage of data on the focal sphere. In next figures we chose the solutions with the smaller uncertainties; if one considers the alternative solutions, the tectonic setting does not change much.

Label	YEAR	MONTH	DAY	Lat (°N)	Long (°E)	Depth (km)	$M_w$	Strike (°)	Dip (°)	Slake (°)	rms (s)	F
1	1990	August	27	44.02	13.177	5.0	3.9	115°	50°	0°	0.10	0.00
2	1991	November	22	43.842	12.082	5.9	3.0	160°	60°	-70°	0.02	0.03
3	1996	June	28	43.769	12.965	27.5	3.4	155°	40°	110°	0.16	0.12
4	2000	February	22	43.79	12.083	8.0	3.0	200°	60°	-120°	0.01	0.13
5	2000	May	5	44.094	13.192	5.0	4.1	190°	20°	30°	0.25	0.20
6	2000	June	25	43.868	13.147	5.0	3.5	130°	90°	-50°	0.16	0.18
7	2000	June	27	43.883	13.200	5.0	3.4	115°	85°	40°	0.06	0.14
8	2000	August	1	43.929	12.318	5.0	4.2	160°	70°	130°	0.02	0.10
9	2000	December	27	43.676	12.245	5.0	3.2	115°	30°	-60°	0.13	0.12
10	1999	February	23	43.70	12.83	26.6	3.8	140°	80°	-30°	0.08	0.84
11	2002	September	8	43.47	12.84	18.8	3.9	130°	70°	-40°	0.15	0.13

TABLE OF SEISMIC EVENTS FROM 1990 TO 2002  
Parameters of the analysed seismic events: good values of rms residuals were obtained for most earthquakes; in particular, the location values (rms) have residuals below 0.25 seconds; furthermore, the polarity quality factor (F) has the values below 0.20.



NEW FAULT PLANE SOLUTIONS  
Compression and dilatation polarities are indicated with crosses and circles, respectively. The 11 focal mechanisms of next figures are the first solutions; in the case of double solutions (5, 7 and 11), the second solutions with a worse stability are shown.

SECTORS WITH DIFFERENT SEISMOLOGICAL EVIDENCES in the Pesaro and Urbino province; the two dashed lines approximate the sector limits.

## 4. CONCLUSIONS

The Northern Apennine chain was described as a tectonic belt characterized by extension. A general agreement exists on the fact that a NE-SW oriented minimum stress axis ( $\sigma_3$ ) is dominant in the axial zone of the chain.

A possible result of this study is the division of the Northern Marche region into three areas with different seismological evidences:

- (a) the inner area of the Apennine belt, which is characterized by extension;
- (b) the Adriatic on-shore, which shows evidence of active compression;
- (c) the Adriatic off-shore, which shows a not very clear evidence of active compression.

## References

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NEW FOCAL MECHANISMS, located in the sectors:

- (a) Apennine belt;
- (b) Adriatic on-shore;
- (c) Adriatic off-shore.

