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Fault plane solutions in the Aegean Sea and the surrounding area and their tectonic implication

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Abstract. Fault plane solutions for 127 earthquakes, of magnitude M ≥ 5.5 and shallow focal depth (h< 60 km), which occurred in the Aegean Sea and surrounding area (34°N- 43°N, 18°E-30°E) during the period 1953-1995, are used to investigate the active tectonics. The geographic distribution of the foci of these earthquakes and the similarity of the fault plane solutions led to the identification of 35 spatial clusters, which in turn define five seismic belts of similar seismotectonic properties. The first belt covers the coastal area of western Albania and western Greece, and is characterized by low angle thrust faults that strike parallel to the coastline (strike: $\xi = 328°$, dip: $\delta = 32°$, rake: $\lambda = 90°$). This narrow zone of thrusting is attributed to the continent-continent collision between the Eurasian and Adriatic plates. The second belt is also of thrust type and extends along the convex side of the Hellenic arc (west of Zante to west of Rhodos). Faults of this belt have an approximately NW strike ($\xi = 310°$, $\delta = 24°$, $\lambda = 102°$) and are attributed to subduction of the eastern Mediterranean oceanic lithosphere (front part of the African plate), and postienlarly to overthrusting of the Aegean plate onto the eastern Mediterranean lithosphere. The third belt is a very wide tensional one and covers most of the Aegean Sea and parts of the adjacent lands (eastern mainland and northern Greece, western Turkey, southern Bulgaria, southern former Yugoslavia). Normal faults in this belt strike in an approximately E-W direction and their dip angles are of the order of 45°. This kind of faulting is attributed to internal deformation, probably caused by gravitational collapse of the expanding area. The fourth belt is also tensional, but faults here strike in an approximately N-S direction. This belt starts in the north from Albania, follows the Hellenides Mountain Range down to eastern Epirus, then is probably interrupted, and is identified again in the southern Peloponnese through the Cretan trough to Rhodos. The cause of deformation in this belt is still a matter

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of controversy and there is no satisfactory interpretation yet. The fifth belt involves dextral strike-slip motion and marks the boundary of the Aegean plate with the Eurasian plate. This belt starts at the North Anatolian fault in the east, crosses the northern Aegean Sea, stops abruptly against central Greece before becoming evident again along the Cephalonia - Lefkada transform fault zone in the west. Faults in this belt are dextral strike-slip ($\xi = 47°$, $\delta = 80°$, $\lambda = 176°$) and they take up the fast southwestward motion of the Aegean plate relative to the Eurasian and African plates.

1. Introduction

Fault plane solutions have been widely used to study active tectonics, as they give information on the orientation of the stress field and on the direction of the plate motions. Furthermore, fault plane solutions combined with seismicity studies can be used to determine the seismic part of the total crustal deformation along plate boundaries.

The Aegean Sea and its surrounding area, shown in Fig. 1, has attracted the attention of many scientists, and fault plane solutions of earthquakes have been determined by first onsets of teleseismic P waves (Hodgson and Cock, 1956; Papazachos, 1961; Delibasis, 1968; McKenzie, 1972, 1978; Ritsema, 1974), by first onsets of P waves of local earthquakes (Hatzfeld et al., 1988, 1996, 1997a; Hatzidimitriou et al., 1991) and by waveform modelling of teleseismic body waves (Kiratzi and Langston, 1989, 1991; Kiratzi et al., 1991; Taymaz et al., 1990, 1991; Papadimitriou, 1993; Baker et al., 1997).

These studies were very useful for understanding the stress field and plate motions in the Aegean Sea and surrounding lands. The key features were: a) identification of the thrust faults that dip from the convex side (Mediterranean Sea) to the concave side (Aegean Sea) of the Hellenic arc (Papazachos and Delibasis, 1969); b) recognition that the broader Aegean area is dominated by an approximately N-S trending extensional stress field (McKenzie, 1970, 1972, 1978); c) recognition of the E-W trending extensional stress field along the western and southern margins of the greater Aegean area (Papazachos et al., 1984a; Kiratzi et al., 1987; Lyon-Caen et al., 1988; Kastens et al., 1996); and d) definition of the Cephalonia transform fault (Scordilis et al., 1985) which plays an important role in the active tectonics of the area. In quantitative terms, interesting results have also been drawn on the crustal deformation of the Aegean area using moment tensor summation and the rate of seismic moment in the deforming volume (Jackson and McKenzie, 1988a, b; Tselentis and Makropoulos, 1986; Ekstrom and England, 1989; Ambraseys and Jackson, 1990; Papazachos and Kiratzi, 1992; 1996; Kiratzi and Papazachos, 1995).

Over the years a significant number of fault plane solutions for the greater Aegean area has been published, determined either for specific seismotectonic studies or reported by the Harvard and NEIC (National Earthquake Information Center) centers. The rapid increase in digital instrumentation and the deployment of new stations in the global networks have greatly improved the reliability of published focal mechanisms. Although most of the published fault plane solutions simply verified what was expected from previous knowledge, there are certain

Table 1 - Parameters of 127 fault plane solutions of strong ($M \geq 5.5$) shallow ($h < 60$km) earthquakes in Greece and the surrounding area.
Ref.: 1. Papazachos et al. (1992), 2. Shirokova (1972), 3. Papadimitriou (1993), 4. McKenzie (1972), 5. Taymaz et al. (1991), 6. Papazachos et al. (1991), 7. Lyon-Caen et al. (1998), 8. Baker et al. (1997), 9. Kiratzi et al. (1991), 10. Anderson and Jackson (1987), 11. Ritsema (1974), 12. Eyidogan and Jackson (1985), 13. McKenzie (1978), 14. Kiratzi and Langston (1989), 15. Papazachos (1975), 16. Taymaz et al. (1990), 17. Soufleris and Stewart (1981), 18. Ekstrom and England (1989), 19. Papazachos et al. (1983), 20. Harvard solution, 21. Papazachos et al. (1984), 22. Scordilis et al. (1985), 23. Dziewonski et al. (1984), 24. NEIS determination, 25. Papazachos et al. (1988), 26. Karakaisis et al. (1993), 27. GSJ (Geological Survey of Japan), 28. Kiratzi et al. (1987), 29. Louvari et al. (1997).

							Plane I			**Plane II**			**P axis**		**T axis**		
	Date	**Time**	**φ°_N**	**λ°_E**	**h**	**M**	**ξ**	**δ**	**λ**	**ξ**	**δ**	**λ**	**ξ**	**θ**	**ξ**	**θ**	**Ref**
1	1953, Mar. 18	19:06:16	40.0	27.4	7	7.4	250	70	-160	153	71	-21	11	28	202	1	1
2	1956, July 09	03:11:40	36.7	25.8	22	7.5	65	40	-90	245	50	-90	155	85	335	5	2
3	1959, Nov. 15	17:08:40	37.8	20.5	10	6.8	46	37	-173	310	86	-53	253	38	10	31	3
4	1963, July 26	04:17:12	42.0	21.4	5	6.1	322	73	-20	38	70	-163	265	25	172	2	4
5	1963, Sep. 18	16:58:08	40.8	29.1	7	6.3	293	56	-99	128	35	-78	174	77	30	11	5
6	1963, Dec. 16	13:4753	37.0	21.0	15	5.9	296	16	101	105	74	87	197	29	11	61	3
7	1964, Oct. 06	14:31:23	40.3	28.2	11	6.9	273	46	-95	101	44	-87	148	85	07	03	6
8	1965, Mar. 09	17:57:54	39.3	23.8	14	6.1	40	90	-6	310	86	-180	87	0	357	0	4
9	1965, Apr. 05	03:12:55	37.7	22.0	28	6.1	226	57	-159	126	74	-35	82	35	178	10	4
10	1965, Apr. 27	14:09:06	35.6	23.5	5	5.7	22	27	-81	191	65	-101	83	71	285	21	7
11	1965, June 13	20:01:51	37.8	29.3	1	5.6	259	38	-90	79	62	-90	347	73	169	17	6
12	1965, July 06	03:18:42	38.4	22.4	28	6.3	281	34	-71	79	58	-102	316	74	177	12	8
13	1966, Feb. 05	02:01:45	39.1	21.7	8	6.2	90	50	-85	263	40	-95	35	84	177	5	8
14	1966, May 09	00:42:53	34.4	26.4	10	5.8	295	40	90	115	50	90	205	05	25	85	4
15	1966, Oct. 29	02:39:25	38.9	21.1	6	6.0	324	40	48	194	61	120	263	11	152	62	8
16	1967, Mar. 04	17:58:09	39.2	24.6	8	6.6	98	54	-107	302	42	-70	320	77	199	05	4
17	1967, May 01	07:09:02	39.5	21.2	11	6.4	2	36	-100	195	55	-83	133	80	280	11	6
18	1967, Nov. 30	07:23:50	41.4	20.4	4	6.3	4	45	-105	205	47	-75	189	79	285	1	8
19	1968, Feb. 19	22:45:42	39.4	24.9	9	7.1	217	86	175	310	82	4	83	03	173	07	9
20	1968, Mar. 29	07:39:59	37.8	20.9	6	5.9	354	34	137	122	67	63	231	20	355	59	10
21	1968, May 30	17:40:26	35.4	27.9	7	5.9	293	25	90	110	76	90	202	20	18	70	4
22	1968, July 04	21:47:51	37.7	23.2	15	5.5	235	40	-125	97	58	-65	56	66	169	10	11
23	1968, Dec. 05	07:52:11	36.6	26.9	7	6.0	86	50	-90	266	40	-90	354	85	177	05	4
24	1969, Jan. 14	23:12:06	36.1	29.2	7	6.2	282	25	95	75	87	2	190	18	05	70	4
25	1969, Mar. 03	00:59:10	40.1	27.5	6	6.0	268	53	108	60	40	68	345	7	74	77	5
26	1969, Mar. 23	21:08:42	39.1	28.5	9	6.1	112	34	-90	292	56	-90	202	79	22	11	12
27	1969, Mar. 25	13:21:34	39.2	28.4	10	6.0	90	40	-105	290	51	-78	257	81	11	08	4
28	1969, Mar. 28	01:48:29	38.5	28.5	8	6.6	281	34	-90	101	56	-90	11	79	191	11	12
29	1969, Apr. 03	22:12:22	40.7	20.0	17	5.8	143	30	90	323	60	90	54	16	233	75	11
30	1969, Apr. 06	03:49:34	38.5	26.4	10	5.9	280	30	-90	100	60	-90	09	75	189	15	4
31	1969, Apr. 16	23:21:06	35.2	27.7	8	5.5	301	30	109	100	60	80	197	16	347	71	4
32	1969, June 12	15:13:31	34.4	25.0	19	6.1	294	29	105	95	61	80	192	17	340	72	4
33	1969, July 08	08:09:13	37.5	20.3	10	5.9	354	18	115	147	74	81	243	30	46	61	3
34	1969, Oct. 13	01:02:31	39.8	20.6	8	5.8	340	30	160	90	80	62	194	31	337	41	10
35	1970, Mar. 28	21:02:23	39.2	29.5	10	7.1	308	35	-90	128	55	-90	38	80	218	10	12
36	1970, Mar, 28	23:11:43	39.1	29.6	10	5.5	73	32	-109	277	60	-78	219	73	359	15	13
37	1970, Apr. 08	13:50:28	38.3	22.6	10	6.2	278	20	-85	90	70	-94	357	75	186	23	13
38	1970, Apr. 16	10:42:22	39.0	29.9	16	5.7	273	30	-99	103	59	-85	29	75	189	16	13
39	1970, Apr. 19	13:29:36	39.0	29.8	10	6.0	104	34	-90	284	56	-90	194	79	14	11	12
40	1970, Apr. 23	09:01:27	39.1	28.6	11	5.6	265	40	-83	78	50	-95	325	84	172	05	13
41	1970, Aug. 19	02:01:52	41.1	19.8	9	5.5	343	20	90	163	70	90	73	65	253	25	4
42	1971, May 12	06:25:15	37.6	29.7	10	6.2	68	40	-90	247	50	-90	160	83	338	05	6

Table 1 - continued.

43	1971, May 12	10:10:38	37.6	29.7	5	5.6	73	14	-90	253	76	-90	161	59	343	21	6
44	1971, May 12	12:57:25	37.6	29.6	7	5.7	79	22	-72	241	70	-97	137	65	347	26	6
45	1971, May 25	05:43:26	39.0	29.7	3	6.1	96	37	-108	298	55	-77	249	76	19	9	12
46	1972, Mar. 14	14:05:47	39.3	29.5	1	5.6	101	40	-101	281	50	-82	231	84	05	07	13
47	1972, May 04	21:39:57	35.1	23.6	40	6.5	308	18	90	129	72	90	219	27	39	63	14
48	1972, Sept. 17	14:07:15	38.3	20.3	8	6.3	46	66	-174	313	84	-49	258	37	07	25	3
49	1973, Jan. 05	05:49:18	35.8	21.9	42	5.6	306	30	82	136	60	93	218	15	46	74	13
50	1973, Nov. 04	15:52:13	38.9	20.5	8	5.8	320	45	80	154	46	100	237	1	143	83	8
51	1973, Nov. 29	10:57:44	35.2	23.8	1	6.0	316	10	90	137	80	90	226	35	44	55	13
52	1975, Mar. 27	05:15:08	40.4	26.1	15	6.6	68	55	-145	316	62	-40	279	47	13	4	5
53	1975, Apr. 04	05:16:18	38.1	22.1	15	5.5	70	75	-130	323	42	-22	300	45	189	20	15
54	1975, Dec. 31	09:45:44	38.4	21.7	1	5.9	235	40	-125	97	58	-65	56	66	169	10	15
55	1976, May 11	16:59:45	37.4	20.4	16	6.5	327	12	90	147	78	90	237	35	57	55	3
56	1976, June 12	00:59:18	37.5	20.6	8	5.8	297	20	90	117	70	90	206	25	26	35	10
57	1977, Aug. 18	09:27:41	35.3	23.5	13	5.6	270	12	114	114	79	96	197	44	29	56	16
58	1977, Sept. 11	23:19:19	34.9	23.0	7	6.3	320	30	90	140	60	90	229	16	59	74	6
59	1978, May 23	23:34:11	40.7	23.2	6	5.8	265	40	-83	76	50	-96	309	83	170	5	8
60	1978, June 20	20:0321	40.8	23.2	6	6.5	278	46	-70	69	48	-110	267	75	173	01	17
61	1979, Apr. 15	06:19:41	42.0	19.0	4	7.1	317	15	90	137	75	90	227	30	47	60	8
62	1979, Apr. 15	14:43:06	42.3	18.9	7	5.8	334	7	106	138	83	88	230	38	46	52	8
63	1979, May 15	06:59:23	34.6	24.5	35	5.7	253	17	65	100	75	97	184	29	16	59	16
64	1979, May 24	17:23:18	42.2	18.8	5	6.3	322	32	90	142	58	90	232	13	52	77	8
65	1979, June 14	11:44:45	38.8	26.6	15	5.9	262	41	-108	105	51	-75	72	77	184	5	5
66	1979, July 23	11:41:55	35.5	26.4	11	5.5	61	35	-40	183	70	-120	56	56	296	17	18
67	1980, July 09	02:10:20	39.3	22.9	10	5.6	82	42	-79	247	50	-101	101	83	345	04	19
68	1980, July 09	02:11:57	39.3	22.9	10	6.5	81	40	-90	261	50	-90	172	85	352	05	19
69	1980, July 09	02:35:52	39.2	22.6	10	6.1	81	40	-90	261	50	-90	171	85	351	05	19
70	1981, Feb. 24	20:53:37	38.2	23.0	10	6.7	264	42	-80	71	49	-98	288	83	167	4	5
71	1981, Feb. 25	02:35:54	38.2	23.1	8	6.4	241	44	-85	54	46	-95	251	86	148	1	5
72	1981, Mar. 04	21:58:07	38.2	23.3	8	6.4	50	45	-90	230	45	-90	56	90	140	0	5
73	1981, Mar. 10	15:16:20	39.4	20.8	3	5.6	324	40	55	187	58	116	259	10	146	66	20
74	1981, Dec. 19	14:10:51	39.2	25.2	8	7.2	37	67	-166	303	77	-22	259	25	352	09	21
75	1981, Dec. 27	17:39:13	38.9	24.9	8	6.5	216	79	175	307	85	11	81	4	172	11	5
76	1982, Jan. 18	19:27:25	39.8	24.4	9	7.0	233	62	-173	140	84	-28	93	24	190	15	5
77	1982, Aug. 17	22:22:20	33.7	22.9	9	6.4	219	34	93	36	57	88	127	11	300	78	20
78	1982, Nov. 16	23:41:12	40.9	19.6	12	5.7	297	35	54	159	63	112	232	15	108	65	20
79	1983, Jan. 17	12:41:30	38.1	20.2	9	7.0	40	45	168	140	82	46	263	25	12	37	22
80	1983, Mar. 23	23:15:05	38.2	20.3	7	6.2	29	68	174	123	74	22	254	12	358	19	22
81	1983, July 05	12:01:27	40.3	27.2	10	6.1	248	70	-155	149	66	-22	109	32	18	02	23
82	1983, Aug. 03	15:43:52	40.0	24.7	8	6.8	138	78	-1	228	89	-168	93	9	2	8	20
83	1984, Feb. 11	08:02:51	38.3	21.9	2	5.6	77	28	-121	291	66	-74	229	65	10	19	20
84	1984, June 21	10:43:46	35.4	23.3	39	6.2	322	16	114	117	75	83	213	30	18	59	3
85	1985, Apr. 21	08:49:42	35.7	22.2	35	5.6	269	36	71	112	56	103	193	10	60	75	24
86	1985, Apr. 30	18:14:13	39.3	22.8	10	5.8	77	50	-106	281	43	-72	284	77	179	3	5
87	1985, July 22	21:32:29	34.4	28.4	23	5.7	67	48	-34	181	65	-133	50	43	301	10	20
88	1985, Sep. 07	10:20:50	37.5	21.2	19	5.6	40	44	-147	285	68	-51	240	51	348	14	20
89	1985, Nov. 09	23:30:43	41.3	23.9	18	5.5	256	33	-85	70	57	-93	329	78	162	12	20
90	1985, Nov. 21	21:57:15	41.7	19.3	1	5.7	306	20	65	153	72	99	236	26	76	62	20
91	1986, Mar. 25	01:41:35	38.4	25.1	3	5.7	261	84	-153	168	63	-7	128	24	31	14	24
92	1986, Sep. 13	17:24:34	37.1	22.2	6	6.0	200	50	-81	06	40	-100	168	83	285	06	25
93	1986, Oct. 11	09:00:11	37.9	28.5	3	6.0	74	58	-140	320	57	-39	288	49	197	1	20
94	1987, Feb. 27	23:34:54	38.4	20.4	4	5.9	46	37	-155	295	75	-55	242	48	359	22	20
95	1987, May 29	18:40:32	37.5	21.5	35	5.5	75	26	-121	289	68	-76	223	65	8	21	20

Table 1 - continued.

96	1987, June 10	14:50:11	37.2	21.4	20	5.5	24	44	180	114	90	46	239	31	349	31	20
97	1987, June 28	00:50:16	32.8	24.3	10	5.8	326	40	-7	62	85	-130	297	37	183	29	20
98	1988, Jan. 09	01:02:47	41.2	19.7	16	5.6	321	12	62	170	80	95	255	35	86	55	20
99	1988, May 18	05:17:40	38.4	20.5	1	5.8	163	38	95	336	52	86	69	7	225	82	20
100	1988, Oct. 16	12:34:05	37.9	20.9	14	6.0	32	87	-166	301	76	-3	258	12	166	8	20
101	1989, Mar. 19	05:36:59	39.2	23.5	10	5.8	230	90	180	320	90	0	95	0	185	0	20
102	1989, Apr. 27	26:06:52	37.1	28.2	12	5.5	92	36	-94	276	54	-87	200	81	4	9	20
103	1989, Apr. 28	13:30:29	37.0	28.1	17	5.6	90	41	-101	285	50	-80	249	81	8	4	20
104	1989, Aug. 20	18:32:30	37.3	21.2	16	5.9	237	37	-130	104	63	-64	56	63	175	14	20
105	1989, Aug. 24	02:13:14	37.9	20.2	18	5.7	356	38	131	129	62	63	258	13	355	63	20
106	1990, June 16	02:16:21	39.3	20.6	15	6.0	329	39	102	133	52	80	230	6	352	80	20
107	1990, July 09	11:22:18	34.9	26.6	19	5.5	327	64	-82	129	27	-106	254	70	51	19	20
108	1990, Dec. 21	06:57:43	41.0	22.4	13	6.0	45	52	-105	249	41	-72	260	77	146	5	20
109	1991, Mar. 19	12:09:25	34.8	26.3	7	5.8	2	71	-122	245	36	-33	234	53	116	20	20
110	1992, Jan. 23	04:24:16	38.4	20.5	15	5.5	351	42	97	162	48	84	256	3	21	85	20
111	1992, Apr. 30	11:44:39	35.1	26.6	20	6.1	172	38	-106	12	53	-78	325	78	93	8	20
112	1992, Jul. 23	20:12:45	39.8	24.4	15	5.5	267	41	-160	161	77	-50	110	44	222	22	20
113	1992, Nov. 06	12:08:09	38.1	27.0	17	6.2	238	85	-167	147	77	-5	104	13	12	6	20
114	1992, Nov. 18	21:10:41	38.3	22.5	12	5.7	258	31	-81	68	59	-95	323	75	161	14	26
115	1993, Mar. 05	06:55:08	37.2	21.5	39	5.8	342	42	120	125	55	66	231	7	341	70	20
116	1993, June 13	23:26:40	39.3	21.8	20	5.5	238	73	-163	143	73	-18	100	24	190	0	20
117	1993, July 14	12:31:48	38.2	21.8	20	5.5	238	73	-163	143	73	-18	100	24	190	0	20
118	1994, Jan. 11	07:22:52	35.8	21.8	37	5.5	332	64	147	77	61	30	25	2	293	41	20
119	1994, Feb. 25	02:30:50	38.8	20.6	4	5.6	6	59	176	97	87	31	227	19	326	24	20
120	1994, Apr. 16	23:09:34	37.4	20.6	15	5.7	346	18	134	114	77	78	215	31	9	56	20
121	1994, May 24	02:05:34	38.8	26.5	21	5.6	258	54	-135	138	55	-45	107	55	198	0	20
122	1995, May 04	00:34:11	40.5	23.6	10	5.8	206	42	-132	131	60	-59	91	61	199	10	20
123	1995, May 13	08:47:13	40.2	21.7	14	6.6	240	45	-101	75	47	-79	60	82	157	1	27
124	1995, June 15	00:15:49	38.4	22.2	12	6.4	276	34	-73	76	58	-101	316	75	174	12	20
125	1995, July 17	23:18:16	40.2	21.5	1	5.5	68	34	-105	266	57	-80	205	76	349	12	20
126	1995, Sept. 28	23:44:42	42.6	18.2	10	5.5	11	72	-144	269	56	-21	235	38	137	11	20
127	1995, Dec. 10	03:27:50	34.8	24.1	25	5.5	289	22	75	125	69	96	210	23	45	66	20
128	Four microearthquakes		39.7	21.1	11	2.2	171	34	-120	27	61	-71	334	68	103	14	28
129	Seven microearthquakes		39.6	21.0	9	2.3	174	28	73	12	64	98	96	18	300	70	28
130	Thirteen microearthquakes		38.7	20.6	19	2.5	18	63	154	121	67	30	249	3	341	37	29
131	Twenty microearthquakes		38.8	21.1	13	2.4	29	85	-161	298	71	-5	255	17	162	10	29

regions where the recent solutions have clarified the tectonic setting. For example, these are now indications of extensive strike-slip faulting over a broad area of western central Greece (NW Peloponnese, Gulf of Patras, Trichonis lake, Amvrakikos Gulf, western coast of Lefkada island) which was not known before. Moreover, during the last decade, various geodetic networks (GPS, SLR, old triangulation) have been deployed, and repeated measurements have led to new discoveries about the tectonics of the eastern Mediterranean area (Billiris et al., 1991; Smith et al., 1994; Oral, 1994; LePichon et al., 1995; Oral et al., 1995; Straub, 1996).

In this paper the fault plane solutions of the shallow (h < 60 km) earthquakes with M ≥ 5.5, which occurred in the Aegean Sea and surrounding lands (34°N- 43°N, 18°E-30°E) during the period 1953 - 1995, are presented and their tectonic significance is discussed.

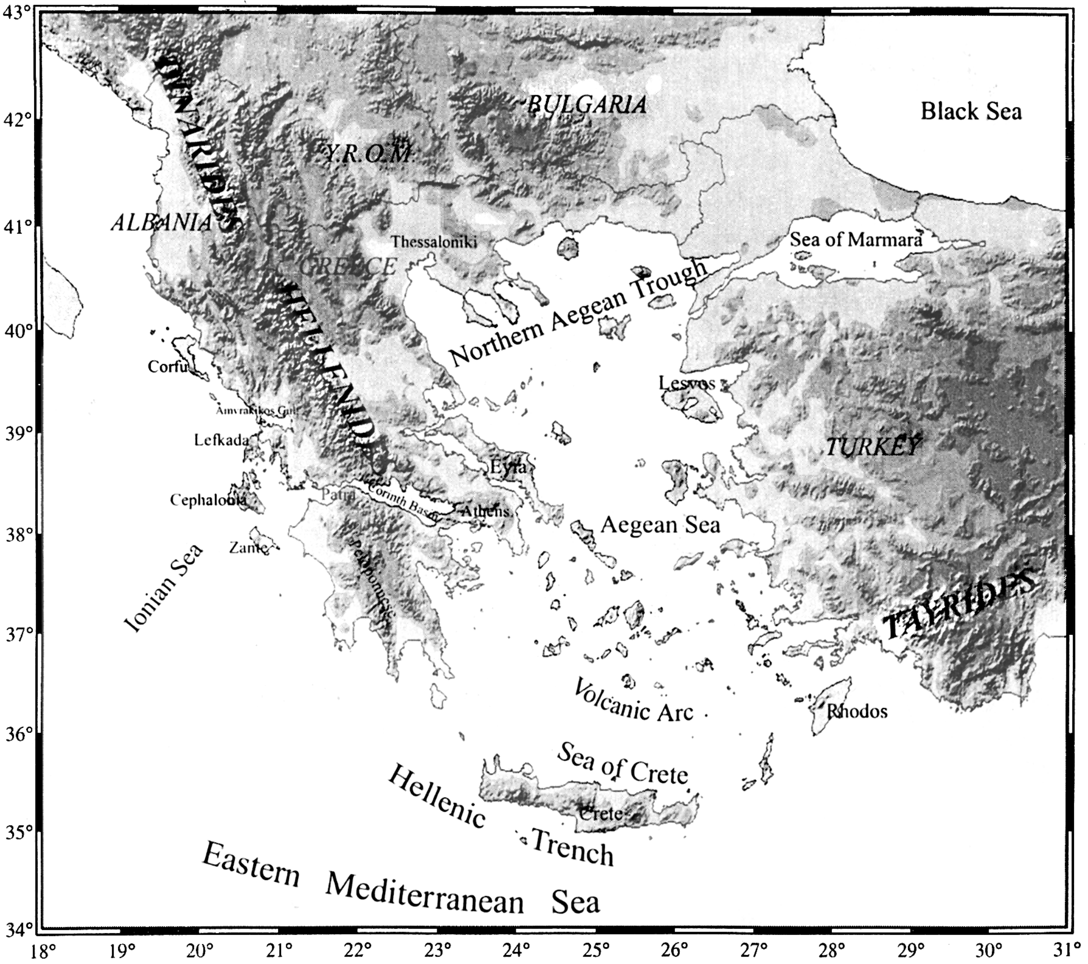

Fig. 1 - The main topographic features of tectonic origin in the Aegean area.

2. The data

Table 1 lists the most reliable fault plane solutions (FPS's) for 127 shallow (h < 60 km) earthquakes, with magnitude M > 5.5, which occurred from 1953 to 1995 in the Aegean Sea and surrounding lands. The last four FPS's in Table 1 (code numbers 128 to 131) are average solutions, obtained from the summation of moment tensors of microearthquakes (Kiratzi et al., 1987; Louvari et al., 1997). They are included in this table and treated as individual mechanisms, since they provide important information on four areas for which focal mechanisms of strong earthquakes are not available. In these particular cases, we adopted the geometric mean of the epicenters of the microearthquakes, and their mean focal depth.

As far as errors in the determination of the FPS's, this information is not always available. The techniques employed for their estimation are not always similar, and the formal errors reported by the various researchers may not always be comparable. However, only strong earthquakes (moment magnitude ≥5.5) are presented in our study (except for the 4 microearthquake clusters),

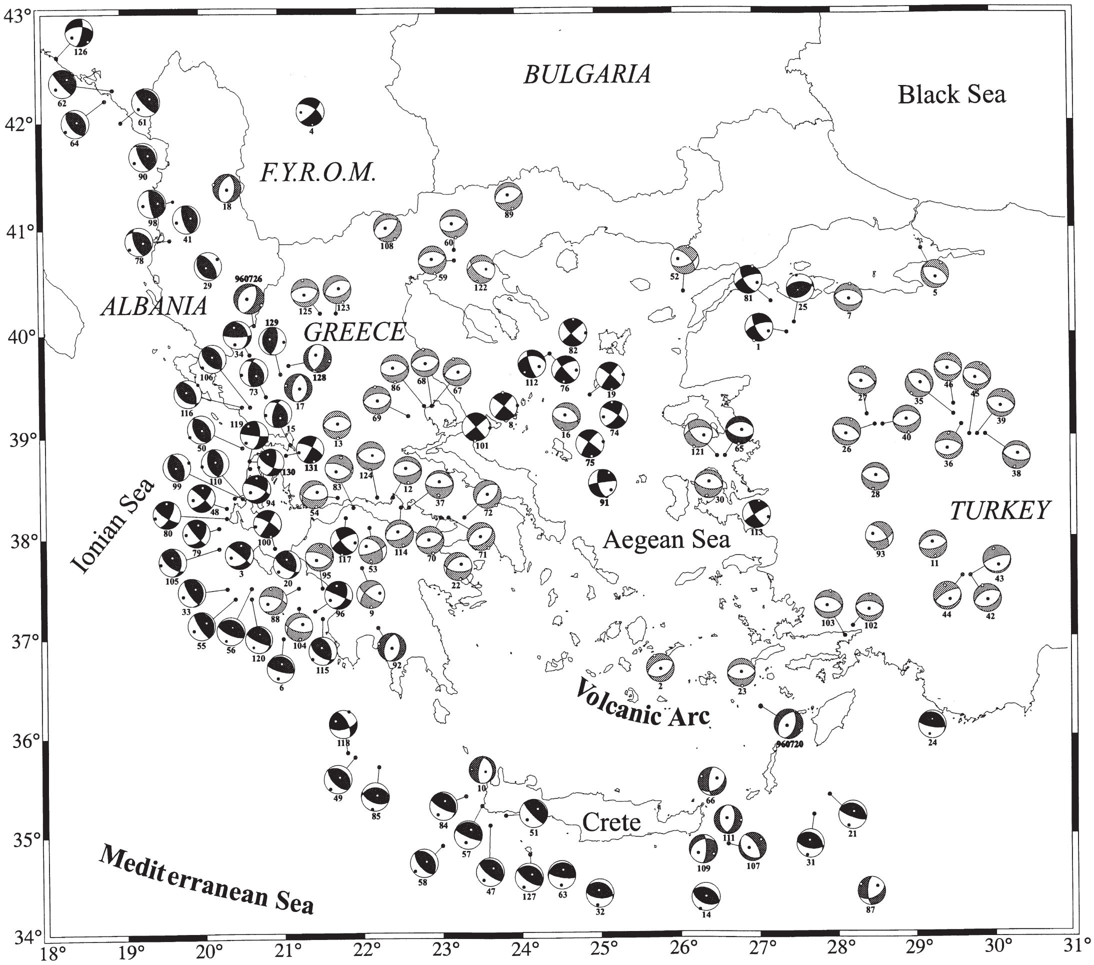

Fig. 2 - Fault plane solutions of shallow earthquakes of the period 1953-1995 with M≥5.5. A lower hemisphere equal area projection is used, with the black quadrants denoting compression and the white ones denoting dilatation. Numbers correspond to table 1, where all the parameters are listed.

so the corresponding FPS's are expected to be quite robust. On the other hand, it is difficult to assign typical errors to the FP (e.g. strike, dip, rake) or P- and T- axis parameters. For instance, the error in azimuth of the P-axis is much larger for normal faults (near vertical P-axis) than for thrust faults. However, on the basis of available error estimates (e.g. Harvard CMT or those presented in specific studies) a typical error of 10-15° (solid angle of 0.03-0.07π) for the principal axes is considered representative for the majority of the FPS's presented in our work.

In several cases of strong earthquakes, more than one FPS was available. Although in most of these cases the solutions were quite similar, only one was selected for inclusion in Table 1. The choice was based on the way the focal mechanism was determined, waveform modelling being preferred to first onset techniques, and on the similarity of any particular solution to other solutions for earthquakes of the region. Fig. 2 shows the data set of the 131 FPS's, as a lower hemisphere equal area projection, with code numbers corresponding to those in Table 1.

3. Seismic belts of similar fault plane solutions

A careful inspection of Fig. 2 and Table 1 shows that several groups of FFS's have similar parameters. On the basis of this similarity, the epicenters of the corresponding earthquakes were grouped to form 35 spatial clusters. The main criterion used was spatial coherency of solutions for areas with horizontal dimension of the order of ~100-200 km. Thus, the spatial distribution of the FPS's was examined as well as their correlation with general geotectonic-morphotectonic features (e.g. Hellenic Arc, North Aegean Trough). Then, the FPS's were grouped according to their specific distribution within the broader seismotectonic unit. For instance for the Hellenic Arc a clear dominance of mainly thrust faults is observed.

Then, these 35 clusters were further grouped to form 5 spatially defined seismic belts that share the same stress field properties, and one typical FPS for each belt was determined. The first belt is the thrust belt-contact of Adriatic-Europe, the second corresponds to the Hellenic Arc (eastern Mediterranean subduction beneath the Aegean) and associated thrust faults, the third belt is the E-W extension between the outer and inner arc, the fourth includes all the back-arc extension, and the fifth belt includes all strike-slip faulting. Therefore, this separation corresponds to the major geotectonic phenomena of the examined area.

The procedure followed has been previously used with very satisfactory results (Papazachos and Kiratzi, 1992, 1996; among a series of papers). For each cluster of earthquakes having similar FPS's, a "typical mechanism" was defined by simply averaging the corresponding moment tensors of the events that belong to each cluster. Hence, if we have a cluster with N focal mechanisms, then the Cartesian components M_{ij}^{n} of the symmetric moment tensor of the nth event, can be represented as $M_{ij}^{n} = M_{0}^{n} \cdot F^{n}(\xi, \delta, \lambda)$ where M_{0}^{n} is the scalar moment of this event, and F^{n} is a function of the strike ξ, the dip δ, and the rake λ, of the corresponding fault plane (Aki and Richards, 1980). Following Papazachos and Kiratzi (1992, 1996) a "representative focal mechanism tensor" **F** was found as a simple average of the $\mathbf{F^{n}}$ tensors. Then the eigenvectors of **F** give the trend and plunge of the P, T and null axis of the "typical focal mechanism", and are associated with the smallest, largest and intermediate eigenvalues, respectively. If all the mechanisms that are included in the summation to get the tensor **F** are identical, the eigenvalues will be equal to -1, 1, and 0. Therefore, the deviation of the eigenvalues of tensor **F** from these values is a measure of the variability of the focal mechanisms summed in any cluster.

Table 2 gives information on these typical FPS's for each cluster. The code name assigned to each of these clusters (i.e. 1a, 1b,...) consists of a number which indicates the belt that the cluster belongs to, and of a lower case letter which indicates the sequential order of the cluster in the specific belt. Examining Table 2, it is seen that all eigenvalues of the P and T axes (r_1 and r_2, respectively) are close to unity (-1 or 1) which strongly indicates consistency between the several FPS's of each cluster. The error on the estimation of the P- and T- axes of the FPS's for clusters (with more than one datum) as well as of the five belts is also given. The average principal axis error is 17°, in good agreement with the previously mentioned error estimate for a single FPS.

Fig. 3 shows the typical FPS's for the 35 clusters of shallow events. From this figure and Table 2, one can observe the similarity in the typical FPS's for the clusters that belong to the

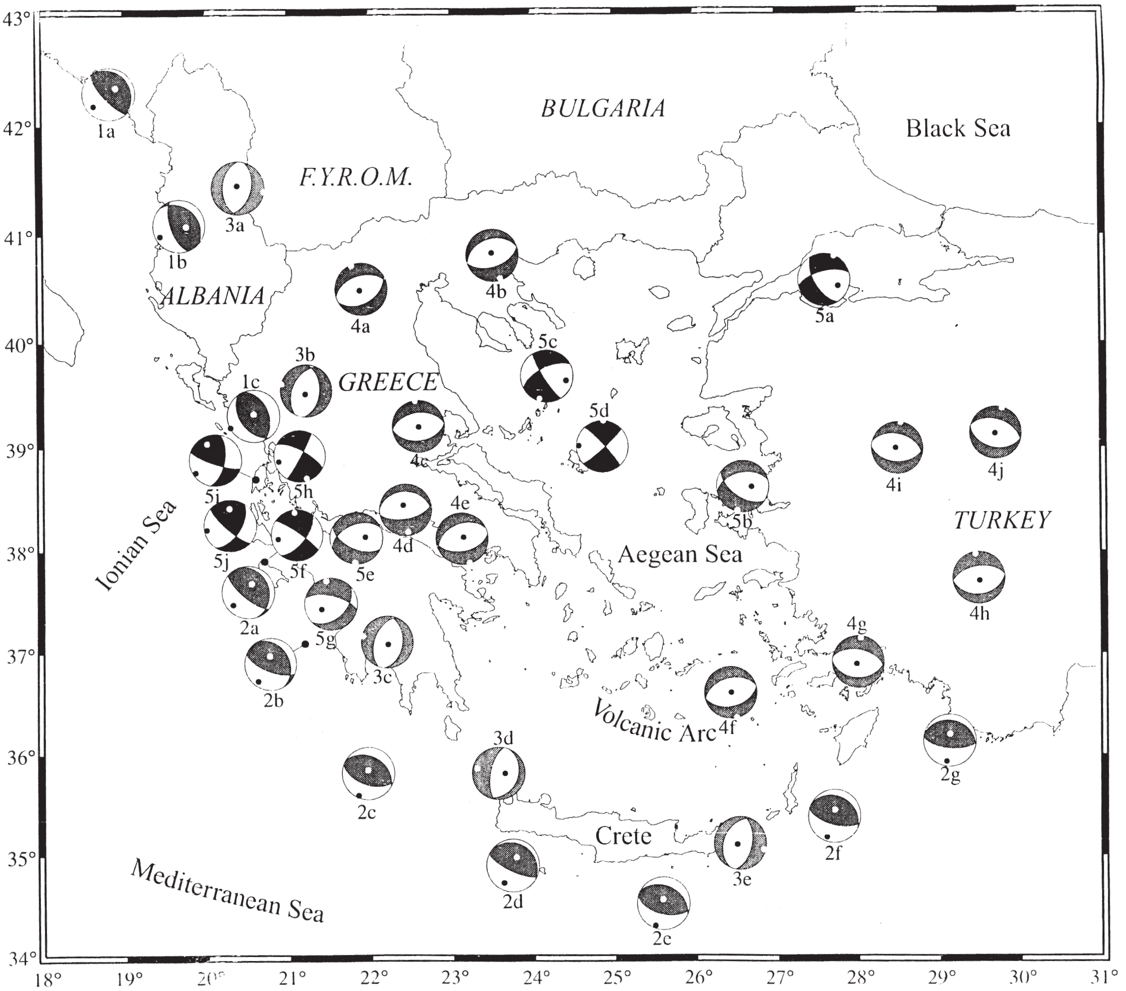

Fig. 3 - Typical fault plane solutions for five belts along the Aegean Sea and surrounding lands. The code name written next to each solution (i.e. 1a) indicates the belt the mechanism belongs to (belt 1) and the sequential order of the cluster within the belt (a).

same belt, even though they spatially cover a broad area. For this reason, and because when studying active tectonics it is always better to view things in a broader sense, a typical FPS's was eventually determined for each seismic belt, summing this time the moment tensor components of all the solutions belonging to the belt. On the basis of these solutions, some of the general properties of the seismic belts are described below.

For each belt the parameters of one nodal plane of the typical FPS, and the azimuth and dip angle of the corresponding slip vector, showing the motion on this plane, are given. In all cases, negative values for the dip angle indicate vectors that are pointing upwards. For belt (2) along the Hellenic trench the nodal plane that shows low-angle thrusting of the Mediterranean under the Aegean lithosphere was considered as the fault plane. For strike-slip belt (5) the nodal plane which indicates dextral motion along Northern Anatolia - Northern Aegean and Cephalonia -

Lefkada area was considered as the fault plane. These choices are based on other information such as surface fault traces, and spatial distribution of aftershocks, etc. For the other three belts (1, 3, 4) the choice of planes presented here is arbitrary and was made to show the basic properties of the typical solution.

3.1. Adriatic coast thrust belt

This zone of thrusting (clusters 1a, 1b, 1c in Table 2) follows the eastern coast of the Adriatic Sea and northern Ionian Sea. Fourteen FPS's of strong shocks grouped in to 3 clusters are available. The typical FPS and the slip vector have the parameters:

$$\begin{array}{c}\text{Plane 1: } \xi = 328°,\ \delta = 32°,\ \lambda = 90°, \\ \text{Slip vector: } \alpha = 238°,\ \varphi = -32°,\end{array} \tag{1}$$

where α is the azimuth, and φ is the plunge of the slip vector. It shows that this is a low angle thrust region with the faults parallel to the coast.

3.2. The Hellenic Trench thrust belt

This seismic belt (clusters 2a-2g), which follows the Hellenic Trench, was first identified by Papazachos and Delibasis (1969) from FPS's available at that time. Twenty-three FPS's of strong shocks grouped in to 7 clusters are now available, and give the following typical solution for the belt:

$$\begin{array}{c}\text{Plane 1: } \xi = 310°,\ \delta = 24°,\ \lambda = 102°, \\ \text{Slip vector: } \alpha = 207°,\ \varphi = -23°,\end{array} \tag{2}$$

It is a low angle thrust belt. In its western part (Zante-SW Crete) the faults have a NW - SE direction, parallel to the coast, and dip from the convex (Mediterranean Sea) to the concave (Aegean Sea) side of the Hellenic arc. The maximum compression is normal to the coast. In the eastern part of the belt (SE Crete - Rhodos) the faults have a WNW - ESE strike. This indicates that the shallow thrust faulting in the eastern part of the convex side of the Hellenic arc is not directly related to the regional topography or to the subduction, but is rather due to a pure overthrusting of the Aegean lithospheric plate.

3.3. The Hellenides Mountain Range tensional belt

This seismic belt (clusters 3a-e in Table 2) follows the Hellenides Mountain Range and is dominated by east-west extension along north-south striking faults. This type of faulting was

Table 2 - Typical fault plane solutions for 35 clusters of shallow earthquakes in Greece and the surrounding area.

					Nodal Plane I			Nodal Plane II			P - axis				T - axis			
		$\varphi°_N$	$\lambda°_E$	*Code number of shocks*	ξ	δ	λ	ξ	δ	λ	ζ	θ	r_1	σ_1	ζ	θ	r_2	σ_2
1. Adriatic Coast													0.78	25.61			0.77	26.08
1a	Montenegro	42.2	18.9	61,62,64	323	18	94	139	72	89	230	27	0.93	9.71	47	63	0.93	9.37
1b	Dyrachium	41.1	19.7	29,41,78,90,98	312	29	65	160	64	103	241	18	0.82	31.53	96	68	0.84	29.92
1c	Jgoumenitsa	39.3	20.6	15, 35,50,73, 106, 116, 129	338	43	98	146	47	82	242	2	0.80	23.64	352	84	0.80	21.20
2. Hellenic Trench													0.86	18.01			0.89	14.58
2a	Zante	37.6	20.5	20, 33, 55, 56, 105, 120	342	22	120	130	71	79	229	25	0.94	15.87	23	62	0.94	15.51
2b	Phyliatra	37.1	21.2	6, 115	329	29	124	112	66	73	215	19	0.87	19.43	353	65	0.97	7.91
2c	Cythera	35.8	22.0	49, 85, 118	300	36	99	110	54	84	204	9	0.93	12.29	354	80	0.78	23.84
2d	SW Crete	35.0	23.7	47, 51, 57, 58, 63, 84, 127	304	18	98	116	72	88	208	27	0.86	14.23	22	62	0.93	9.23
2e	SE Crete	34.4	25.7	14, 32	296	35	99	105	56	84	200	11	0.97	8.79	354	78	0.98	7.55
2f	Karpathos	35.3	27.8	21, 31	297	27	100	106	63	85	200	18	1	3.12	5	71	0.99	5.14
2g	Rhodos	36.1	29.2	24	282	25	95	96	65	88	188	20	1	15.77	2	70	1	13.06
3. Hellenides Mountain Range													0.82	18.91			0.80	18.56
3a	Ochrida	41.4	20.4	18	182	44	-99	15	47	-80	353	83	0.88		98	2	0.92	
3b	Drosopighe	39.5	21.2	17, 128	4	45	-104	205	47	-74	189	79	1	15.77	285	1	1	13.06
3c	Kalamata	37.1	22.2	92	6	40	-100	200	50	-81	160	82	1		284	5	1	
3d	NW Crete	35.6	23.5	10	22	27	-81	191	65	-94	92	71	1		285	18	1	
3e	E. Crete	35.1	26.5	66, 107, 109, 111	203	38	-79	10	53	-97	247	80	0.75	23.80	105	8	0.67	27.16
4. Main Tensional Belt													0.90	12.50			0.86	16.64
4a	Kozane	40.5	21.9	108, 23, 125	60	44	-98	253	47	-80	231	83	0.95	10.30	337	2	0.95	10.52
4b	Volve	40.8	23.5	59, 60, 89, 122	252	37	-88	71	53	-90	338	82	0.93	13.88	162	8	0.95	15.52
4c	Thessalia	39.2	22.6	13, 67, 68, 69, 86	83	44	-88	262	46	-90	143	89	0.98	6.95	352	1	0.98	6.32
4d	Aeghio	38.4	22.3	12, 37, 114, 124	272	30	-78	79	61	-95	333	73	0.97	5.06	174	16	0.96	8.74
4e	Corinth	38.1	23.1	22, 70, 71, 72	246	42	-99	79	49	-80	45	83	0.96	9.68	163	3	0.94	11.35
4f	Amorgos	36.6	26.3	2, 23	254	45	-92	77	45	-86	75	88	0.99	5.07	166	0	0.95	12.07
4g	Mugla	37.0	28.1	102, 103	91	38	-96	281	52	-83	221	82	0.99	3.73	6	7	1	3.21
4h	Burdur	37.7	29.4	11, 42, 43, 44, 93	84	36	-87	262	54	-90	167	81	0.77	22.84	352	9	0.79	19.98
4l	Demirzi	39.0	28.5	26, 27, 28, 40	93	45	-97	284	46	-81	275	85	0.95	8.11	8	0	0.92	13.60
4j	Gediz	39.1	29.7	35, 36, 38, 39, 45, 46	103	42	-92	287	48	-87	228	87	0.91	11.30	15	3	0.88	15.34
5. Strike slip Belt													0.43	42.54			0.65	24.70
5a	Erdek	40.6	27.6	1, 5, 7, 25, 52, 81	256	64	-145	149	60	-30	114	45	0.45	44.84	22	2	0.70	20.55
5b	Chios	38.6	26.6	30, 65, 113, 121	257	46	-127	125	55	-57	92	63	0.75	26.53	193	5	0.96	9.46
5c	Lemnos	39.7	24.2	8, 76, 82, 101, 112	243	64	-167	148	80	-26	103	26	0.54	21.00	198	10	0.55	19.75
5d	Skyros	39.0	24.9	16, 19, 74, 75, 91	48	83	-172	317	83	-6	272	10	0.58	34.68	2	0	0.80	17.85
5e	Patra	38.1	21.9	9, 53, 54, 83, 117	247	47	-127	116	55	-56	84	63	0.53	36.69	184	5	0.87	14.35
5f	Killine	37.9	20.7	3, 100	39	62	-169	304	81	-27	258	26	0.94	13.36	354	13	0.85	22.86
5g	Pyrgos	37.4	21.3	88, 95, 96, 104	47	42	-137	283	64	-55	240	57	0.69	25.85	349	12	0.85	17.05
5h	Amvrakikos	38.4	21.1	131	29	85	-160	297	71	-4	255	17	1	-	162	10	1	-
5i	Leukada	38.7	20.6	119, 130	11	60	165	109	77	31	237	11	0.94	36.85	334	31	0.97	51.66
5j	Cephalonia	38.2	20.3	48, 79, 80, 94, 99, 110	33	56	163	132	76	35	259	12	0.86	18.84	358	35	0.69	27.38

identified by the use of FPS's of both strong earthquakes (Papazachos et al., 1984a) and microearthquakes (Kiratzi et al., 1987). The zone starts from NE Albania, runs along the backbone of Greece following the Hellenides mountains, and the currently available data indicate that it ends west of Rhodos. There is no evidence today that this E-W trending tensional belt continues in to southern Turkey following the Taurides Mountain Range. The belt can be separated into two branches, a northern and a southern, since it seems to be interrupted in central Greece. Its southern part (southern Aegean) has been further investigated by the use of neotectonic and seismological data (Armijo et al., 1992) as well as geodetic data (Kastens et al., 1996). Nine FPS's grouped in to five clusters give the following typical solution for both branches of this belt:

$$\begin{gathered}\text{Plane 1: } \xi = 11°,\ \delta = 46°,\ \lambda = -93°, \\ \text{Slip vector: } \alpha = 105°,\ \varphi = 44°,\end{gathered} \tag{3}$$

The FPS's of two recent strong earthquakes belonging to this belt, which occurred in 1996 and were not included in our data set of Table 1, are in good agreement with (3). The first occurred in the southern part of the belt, west of Rhodos, (July 20, 1996; 36.3°N, 27.0°E, M=6.3) and its Harvard CMT solution is: NP1 (ξ=219°, δ=42°, λ=-73°), NP2: (ξ=16°, δ=50°, λ=-105°) with T-axis trending N117°E. The second event occurred in the northern part of this belt, close to the city of Konitsa, (July 26, 1996, 39.9°N, 20.8°N, h=11km, M=5.5) and its Harvard CMT solution is: NP1 (ξ=215°, δ=36°, λ= -79°), NP2: (ξ=22°, δ=54°, λ=-98°) with the T-axis trending at N117°E.

3.4. The main tensional Aegean belt

An almost north-south extension over a very broad area that includes the Aegean Sea and surrounding lands was first suggested by McKenzie (1970, 1972, 1978). This is a continuous tensional belt which includes south Bulgaria and former Yugoslavia, northern and central Greece, the southern Aegean volcanic arc, southwestern and central western Turkey (clusters 4a-4j in Table 2). Thirty nine FPS's of strong earthquakes grouped in to 10 spatial clusters were used to give the following typical solution for the belt, which shows that N-S expansion leads to N-S slip on E-W striking normal faults:

$$\begin{gathered}\text{Plane 1: } \xi = 82°,\ \delta = 46°,\ \lambda = -92°, \\ \text{Slip vector: } \alpha = 175°,\ \varphi = 44°,\end{gathered} \tag{4}$$

3.5. The strike-slip belt

This belt has a general NE-SW trend. It starts in the western part of the North Anatolian Fault and continues to the northern Aegean Sea (5a-5d in Table 2) as for as the central Greek mainland, where it is interrupted. Then it continues in the western Peloponnese and Ionian islands (5e - 5j in Table 2) and ends in the Cephalonia Transform Fault (CTF). Its northeastern branch was identified long ago from field observations along the North Anatolian Fault, but its southwest branch was recognized and investigated by seismological and geodetic means (Scordilis et al., 1985; Kiratzi and Langston, 1991; Papadimitriou, 1993; Papazachos et al., 1994; Louvari et al., 1997). Forty FPS's of strong earthquakes and two solutions obtained from microearthquakes, grouped in to 10 clusters (Table 1), result in the following typical FPS for this belt:

$$\begin{gathered}\text{Plane 1: } \xi = 47°,\ \delta = 88°,\ \lambda = 176°, \\ \text{Slip vector: } \alpha = 227°,\ \varphi = 4°,\end{gathered} \tag{5}$$

This belt represents a broad wrench, which is due to the westward motion of the Anatolian plate and to the fast southwestward motion of the Aegean lithosphere. It should be noted that the typical FPS's corresponding to clusters 5b, 5e and 5g have almost equal parts of normal and strike-slip components. It should also be noted that relations (5) give an average focal mechanism, since some earthquakes of this belt, mainly in the western branch of the North Anatolian Fault and its continuation in the Aegean Sea, were generated by pure normal or pure thrust faulting.

4. Plate motions and focal mechanisms in the Aegean area

The Eurasian, African and Arabian plates are the principal ones affecting active tectonics in the Aegean Sea and surrounding area. The motions of these big plates, however, are not large enough to explain the basic seismotectonic properties of the region, and the contribution to the deformation by three additional plates of smaller dimensions (microplates), namely the Anatolian, Aegean and Adriatic plates, has also been taken into account. Fig. 4 shows a schematic representation of the major plates involved in the active tectonics of the eastern Mediterranean, the boundaries of the microplates involved, and the velocities of their motion relative to Eurasia.

It can be assumed that, provided we average over lengths comparable to the lithosphere thickness, the deformation of the upper crust approximates the distributed flow in the rest of the lithosphere beneath it. It is also well known that a fundamental question in continental tectonics concerns the velocity field that describes the deformation of the lithosphere at large length scales, and how faulting in the upper crust accommodates this velocity field. There is no known relation between the velocity field and faulting, and the information we can get from that about the interaction between the upper crust and the creeping lithosphere beneath it. It is generally believed that the structural anisotropy of the upper crust influences the direction in which faulting forms or reactivates. Moreover, the overall velocity field may adjust with time to keep these faults active, as they and the blocks they bound rotate. We believe that even though the deformation in the Aegean could be represented by a continuous velocity field one cannot neglect the effect of the plate motions in this area.

The convergence between the Eurasian and African lithospheric plates is taking place in a N-S direction (N181°E) along the Hellenic Trench, and the calculated rate of this convergence (at 35°N, 31°E) is 1 cm/yr (Chase, 1978; Minster and Jordan, 1978; DeMets et al., 1990), while the motion of the Aegean area relative to Africa is taking place at a much greater rate (~5-6 cm/yr) in a SW direction (Kastens et al., 1996).

The Arabian plate moves in a NNW direction and its rate of convergence relative to Eurasia, in the region of the Caucasus mountains (at 38°N, 40°E), is ~3 cm/yr (Chase, 1978;

Minster and Jordan, 1978; DeMets et al., 1990; Oral et al., 1995). The motion of the Arabian plate only indirectly affects active tectonics in the Aegean, in the sense that it causes the westward escape of Turkey relative to Eurasia, towards the Aegean. The North East Anatolian strike-slip faults accommodate this escape (Sengor et al., 1985). On the other hand, along coastal Albania and former Yugoslavia, active continental shortening and crustal thickening occur, caused by the collision of this region with the Adriatic and Apulian platforms. It is now thought that it is this collision that resists the westward motion of Anatolia and forces the Aegean Sea to the SW, where it can easily override the Mediterranean oceanic crust along the Hellenic Trench.

The Anatolian plate is rotating counter-clockwise, relative to Eurasia, at a rate of 1.2°/Ma about an Euler pole located north of the Sinai peninsula (31.1°N, 33.4°E), which indicates a velocity of 2.5 cm/yr at the North Anatolian Fault (Oral et al., 1995). This westward motion of Anatolia does not cause a compressional stress field in the Aegean area: on the contrary, the area is dominated by extensional tectonics. As mentioned before, the Aegean moves towards the SW, as a more or less coherent unit, relative to Eurasia, with a velocity (4-5 cm/yr) much higher than the corresponding velocity of the Anatolian plate (Kastens et al., 1996). For this reason, the Aegean area forms a separate microplate called the Aegean plate (McKenzie, 1970). The available FPS permit a better definition of the boundaries as well as of other properties of this plate.

The southern boundary of the Aegean plate is defined by the low angle thrust faults of shallow earthquakes (Fig. 2) located along the Hellenic Trench (west of Zante - south of Crete - east of Rhodos). The mean direction of seismic slip in these faults is in agreement with GPS data, which suggest a southwestward motion of the Aegean plate, both relative to Africa and Eurasia. The seismic (brittle) part of the deformation along this boundary is about 1.3 cm/yr (Papazachos and Kiratzi, 1996), while the velocity of the southern Aegean relative to Africa is 5-6 cm/yr (Kastens et al., 1996), which means a low efficiency ratio (seismic/total deformation) along this boundary. It seems that plate interaction along this boundary is of an ocean - continent character, especially in the southeastern Ionian (area of Cythera), since recent tomographic work (Papazachos and Nolet, 1997) shows that remnants of oceanic crust still exist beneath the Hellenic trench there. It should be noted, however, that in the shallow depths of the Ionian sea deformation is mainly caused by the overthrusting of the fast-moving Aegean plate onto the African plate.

The northwesternmost boundary of the Aegean plate is dominated by the Cephalonia Transform Fault (CTF). The slip direction on this fault (N213°E, see Table 2) is in agreement with the southwestward motion of the Aegean, and the rate of seismic slip (~3cm/yr) is the highest observed throughout the Aegean area (Papazachos et al., 1994; Papazachos and Kiratzi, 1996). On the other hand, the efficiency ratio for the Aegean area has been estimated to be ~ 0.5 (Papazachos et al., 1992). If this ratio holds also for the CTF, then the rate of total deformation in this fault is 6 cm/yr, in agreement with the velocity of the southwestward motion of the Aegean plate relative to Africa.

The dextral strike-slip fault belt (belt 5 in Table 2 and Fig. 3) defines the northern boundary of the Aegean plate. It starts in the western part of the North Anatolia strike-slip fault and ends in the Amvrakikos gulf (39°N, 21°E), which is considered as a triple junction of the Aegean,

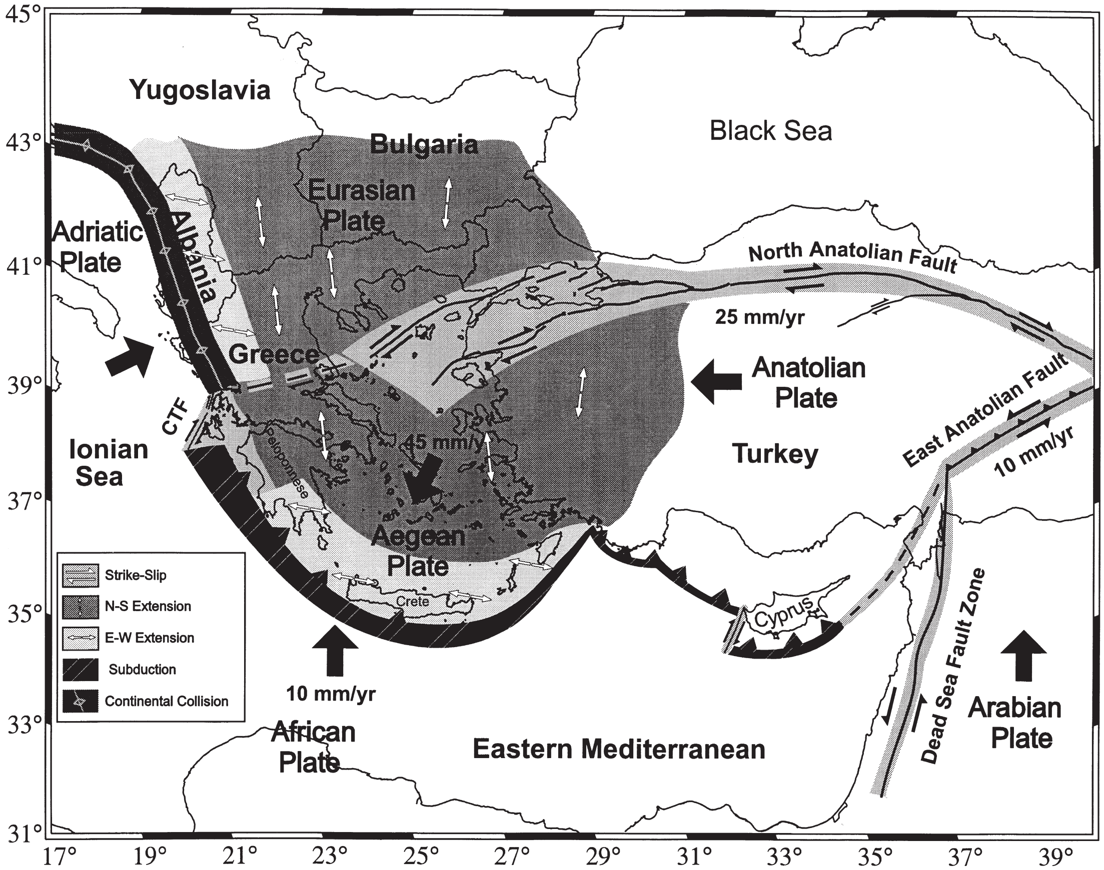

Fig. 4 - Simplified map of the Aegean Sea and the surrounding area showing the large plates involved in the active tectonics. Black arrows indicate the motion of the plates relative to Eurasia (from DeMets et al., 1990; Kastens et al., 1996; Oral et al., 1995). The small white arrows indicate the direction of internal deformation (extension) over the grater Aegean area.

Eurasian and Adriatic plates (King et al., 1993). The azimuth of the slip vector decreases from northeast to southwest, which indicates a counter-clockwise rotation of the Aegean plate, but the average azimuth is ~ N227°E, in agreement with the general SW motion of the Aegean shown by GPS measurements.

The eastern boundary of the Aegean plate is not well defined, but is characterized by extension over a broad area along E-W striking normal faults. This belt covers western Turkey, south of the Northern Anatolian Fault, to the 30°E meridian.

The Adriatic lithospheric microplate is considered as an extension of the African lithospheric plate (a wedge) in the area between Italy and former Yugoslavia - Albania - west central Greece. It has been suggested that this microplate is rotating counter-clockwise (McKenzie, 1972; Ritsema, 1974; Anderson and Jackson, 1987), resulting in a convergence of this plate with the Eurasian plate along the eastern Adriatic and north Ionian coastal area, and contributing to the generation of earthquakes with thrust faulting (see belt 1 in Table 2 and Fig. 3). It is a continent - continent collision and the mean direction of the slip vectors is about N60°E. The dextral strike-slip motion on the CTF is in agreement with a counter-clockwise rotation of the Adriatic microplate (see Fig. 4). The strike-slip fault just southwest of Cyprus (Fig. 4), identified and called the Paphos Transform Fault by Papazachos and Papaioannou (1997), is very similar to the CTF.

The distribution of shallow earthquakes in the Aegean Sea and surrounding land show that earthquakes do not occur only along the boundaries of the lithospheric plates described above, but also within them. This indicates that a considerable amount of internal deformation occurs in these plates, especially in the Aegean plate and north of it (northern Greece, eastern Albania, southern former Yugoslavia, and southern Bulgaria) where this deformation is generally of extensional character.

The mean direction of the slip vectors in the main tensional belt (belt 4 in Table 2 and Fig. 3) is 352°, and the mean direction of the T-axis is N6°W, which shows that this internal deformation occurs by extension in an almost north-south direction. It is worth noting that both the western (~21°E) and eastern boundaries (~30°E) of this north-south expanding area have their southern ends in the western and eastern limits of the Hellenic arc. This indicates a genetic relation between these two regimes. Such a relation could be the gravitational spreading or gravitational collapse of the expanding area due to rollback of the descending lithospheric plate towards the remaining scrap of oceanic crust beneath the Ionian sea (LePichon and Angelier, 1981; Dewey, 1988). The fast southwestward motion of the Aegean lithosphere could also be attributed to the same driving mechanism. This idea is strongly supported by new tomographic results which show that the descending lithospheric slab is located at a depth of about 90 km in the southwestern part of the Hellenic trench, while in its western and eastern parts the slab is at a depth of about 60 km (Papazachos and Nolet, 1997). Moreover, this is also supported by a recent relocation of intermediate depth earthquakes, which shows that under the southwestern part of the trench focal depths reach 100 km or more (Papazachos et al., 1997).

The internal deformation close to the western- and southern- convergence boundaries is performed by an almost east-west expansion (see belt 3 in Table 2 and Fig. 3). The mean slip direction is 281° and the mean direction of the T-axis is 104° for this belt. Several attempts have been made to interpret this east-west expansion in the southern part (southern Aegean) of this belt (Lyon-Caen et al., 1988; Armijo et al., 1992; Hatzfeld et al., 1997b; Kastens et al., 1996). All these interpretations are based on the assumption of an ocean - continent collision, which that does not hold for the northern part of this belt (central Albania- central Greece, as in Fig. 4). It is possible that the cause of the E-W extension in the southern Aegean is different from that in the northern part of this belt. However, whatever the case, the interpretation of this E-W extension is still open to further investigation.

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