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Modern tectonic stress field in the Mediterranean region: evidence for variation in stress directions at different scales

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SUMMARY

A compilation of more than one thousand stress indicators (which include *in situ* stress measurements, focal mechanisms, microtectonic and other geological data) allowed us to reconstruct the modern stress field in the Mediterranean region and the surrounding area. Average stress directions at different scales have been reconstructed by means of a linear interpolation method. This method takes into account the distribution, scale and quality of stress data. The results of the interpolation at plate scale, allow us to recognize slightly deformed regions such as the northwestern European platform, where average maximum horizontal stress direction is oriented roughly NNW–SSE, subparallel to absolute and relative plate velocity directions. Other regions such as the Caucasus, Alps and Pyrenees, where recent tectonic deformation and seismicity are present, display important variations of stress directions. The reconstruction of the average stress directions at different scales within the French Alps pointed out that the average stress field pattern may vary from one scale to another. Nevertheless, variations of stress directions at a given scale are consistent with the kinematics of faults of the same scale.

Key words: interpolation, Mediterranean, recent tectonics, scale effect, stress deviations, stress field.

1 INTRODUCTION

Several attempts to map recent and present-day stress field in different regions and at different scales have recently been published (Richardson, Solomon & Sleep 1979; Zoback & Zoback 1980; Huang, Bergerat & Angelier 1987; Philip 1987; Zoback *et al.* 1989). These maps, like the ones presented in this paper, result from comprehensive compilations and analysis of available information on present-day and recent tectonic stress and make use of both geological and geophysical stress indicators: earthquake focal mechanisms, *in situ* stress measurements and young geological features (microtectonic observations, young volcanic alignments, etc.).

All these studies, especially the one by Zoback *et al.* (1989), illustrate the overall consistency of stress orientation inferred from these different types of indicators, despite the variety of techniques used and the different ranges of depths sampled. Zoback *et al.* (1989) have concluded that in several plates the maximum horizontal stress is subparallel to the direction of absolute plate motion. The world stress map (Zoback *et al.* 1989) allows us to verify this assertion in some regions (North America, northwestern Europe); although in many other cases such as recent mountain belts and even old cratonic domains (i.e. Australia), stress directions are not always parallel to plate motion trajectories.

As will be shown in this paper, many well documented examples in the Mediterranean region demonstrate that principal stress directions are different from the African and European absolute and relative plate velocity directions. On the other hand, geodynamic models considering smaller-scale features (the displacement of microblocks caught between two large converging plates), seem to account better for the global stress pattern of this region (Drewes & Geiss 1986). These models are more suitable because they consider heterogeneities and discontinuities at smaller scales.

At regional and outcrop scales, microtectonic studies (Arthaud 1980, in Mattauer & Mercier 1980; Rispoli 1981; Granier 1986; Ritz 1986; Taha 1986; Rebaï 1988; Petit & Barquins 1990) have shown that the orientation of palaeostresses in a site is a function of the local structures and can be quite different from the average regional stress direction.

An example of reconstruction of principal stress

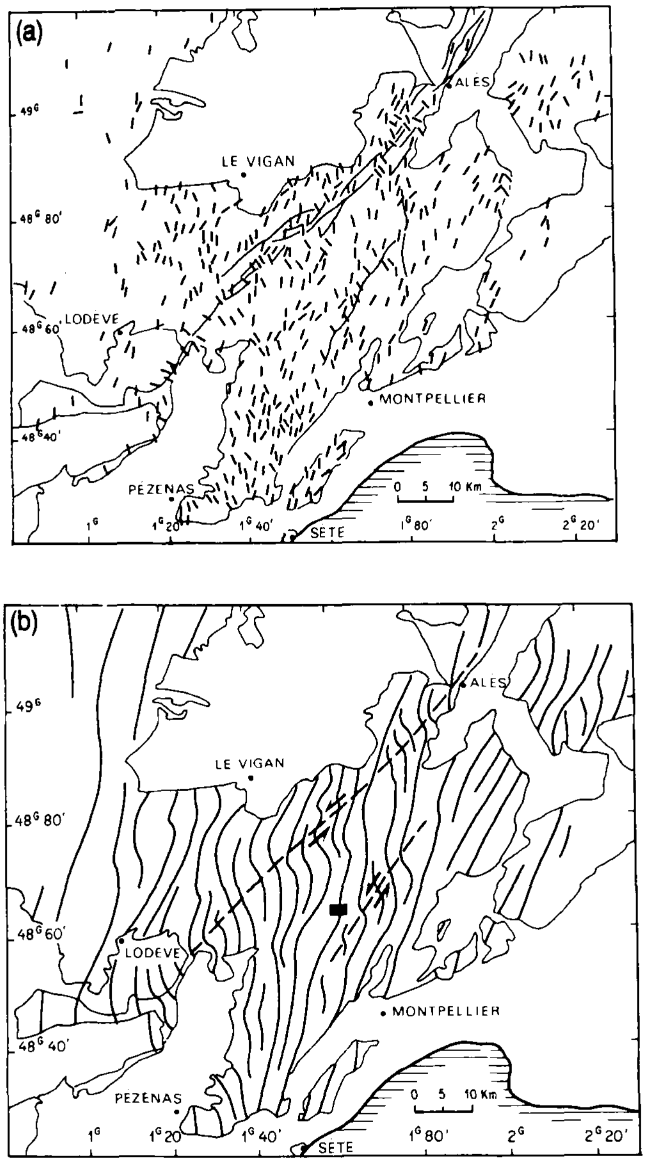

Figure 1. Regional variations of 'Pyrenean' palaeostress directions deduced from 5000 microtectonic measurements within the Languedoc region (southern France) (Arthaud 1980, in Mattauer & Mercier 1980). (a) Map of principal compressive stress directions (S_{hmax}) and (b) S_{hmax} trajectories (continuous lines) obtained from the previous map; the intermittent lines indicate major strike–slip faults. Black square indicates the location of Fig. 2.

trajectories at the regional scale is shown in Fig. 1. Stress trajectories for the Pyrenean tectonic phase in Languedoc (southern France), have been constructed from microtectonic analysis at outcrop scale. Notice that the average S_{hmax} direction is close to north–south, yet variations are observed close to large strike–slip faults. Analogue observations carried out on a polished Mesozoic limestone sample from Languedoc are shown in Fig. 2. Stress indicators such as stylolites and tension gashes (Arthaud & Mattauer 1969) allow us to reconstruct the stress trajectories at this scale. Notice also that as in the previous case (Fig. 1) the principal stress directions display variations close to microfaults. In some cases, discontinuities of stress direction are also present on either sides of microfaults. Nevertheless, the stress pattern is consistent with fault kinematics (Figs 1 and 2).

These examples point out the scale problem inherent with the definition of stress state. In particular, it is not justified to define a state of stress that is representative of all scales. This assertion allows us to introduce the concept of 'average' state of stress at a given scale. Consequently, at any scale, *stress deviations* are defined as the angular difference between the 'local' stress direction and the average stress direction at a larger scale (Fig. 3).

The main purpose of this paper is to discuss stress deviations at different scales of the modern stress field (mid-Pleistocene to present day) in the Mediterranean region. We emphasize the relationship between horizontal principal stress directions (S_{hmax} and S_{hmin}), geological structures and seismotectonic context.

2 GEODYNAMIC AND GEOLOGIC SETTING OF THE MEDITERRANEAN AND SURROUNDING AREA

The Mediterranean region consists of an assemblage of relatively small lithospheric blocks with a wide variety of thicknesses and rheologies (oceanic and thinned continental lithosphere of Mesozoic and Cenozoic age, normal or thickened continental lithosphere, etc.). These blocks are trapped between the relatively undeformable African and north European platforms which have been converging along a N–S to NNW–SSE direction for the last 70 My (Pitman & Talwani 1972; Dewey *et al.* 1973; Le Pichon, Sibuet & Francheteau 1977; Tapponnier 1977; Minster & Jordan 1978; Savostin *et al.* 1986). This convergence is stronger in the eastern part of the Mediterranean ($3\,cm\,yr^{-1}$) than in the western part ($1\,cm\,yr^{-1}$) (McKenzie 1972), and is absorbed either within subduction zones in the central Mediterranean (Aegean and Tyrrhenean) or within collision zones in the western and eastern Mediterranean (Fig. 4).

Subduction and collision in the Mediterranean region lead to a variety of stress states within areas of variable size. These stress states can be compressive or extensive, and are often associated with strike–slip faulting. Thickened continental lithosphere is found in continental collision zones such as the Alps, the Carpathes, the Caucasus and the Pyrenees (Fig. 4). These mountain chains are characterized by intense thrusting subperpendicular to the local convergence direction. Convergence may also lead to lateral expulsion of large lithospheric blocks along large-scale strike–slip faults. Lateral expulsion is favoured by free edge boundary conditions such as the Aegean Sea in the case of the Anatolian microblock ejection.

Thinned continental lithosphere, either old or recent, localizes extensional deformation and can be associated with different tectonic contexts. Current or recently thinned continental lithosphere affected by normal faulting is present in back-arc basins of the Aegean and Tyrrhenean subduction zones. On the other hand, continental lithosphere thinned during the Cenozoic (such as the Rhine graben system), localizes normal faults associated with strike–slip faulting. Most of these regions are characterized by recent volcanic activity.

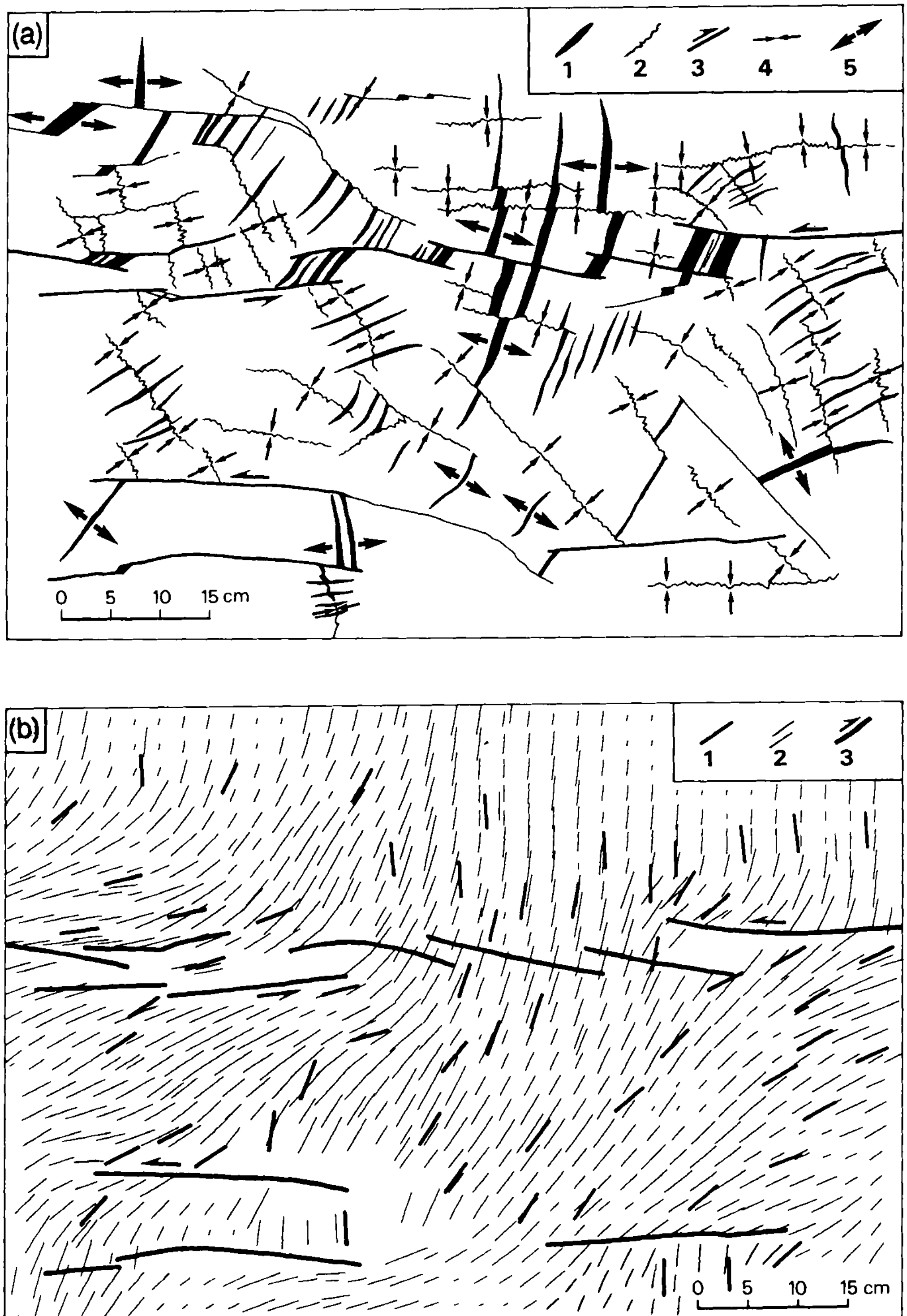

Figure 2. Microtectonic variations of 'Pyrenean' palaeostress directions at decimetric scale in Mesozoic limestone (Languedoc, southern France). (a) Sample showing tension gashes and stylolites (modified from Xiaohan 1983); 1—tension gash; 2—stylolitic joint; 3—microfault; 4—S_{hmax} direction; and 5—S_{hmin} direction. (b) Interpolated S_{hmax} directions deduced from tension gashes and stylolite peaks. Main variations and discontinuities of S_{hmax} direction are associated to decimetric faults; 1—mean S_{hmax} direction; 2—interpolated S_{hmax} direction; and 3—microfault.

In addition to continental lithosphere, both young and old oceanic lithosphere are also present. The main characteristic of this lithosphere is its rigidity in comparison to continental lithosphere. Thus, the oceanic lithosphere is little or weakly deformed and the deformation is concentrated mainly in continental areas adjacent to oceanic lithosphere, as indicated by the distribution of seismicity.

In conclusion, several large zones have been recognized at the Mediterranean scale, each of which displays a relatively homogeneous deformation. These zones are limited by

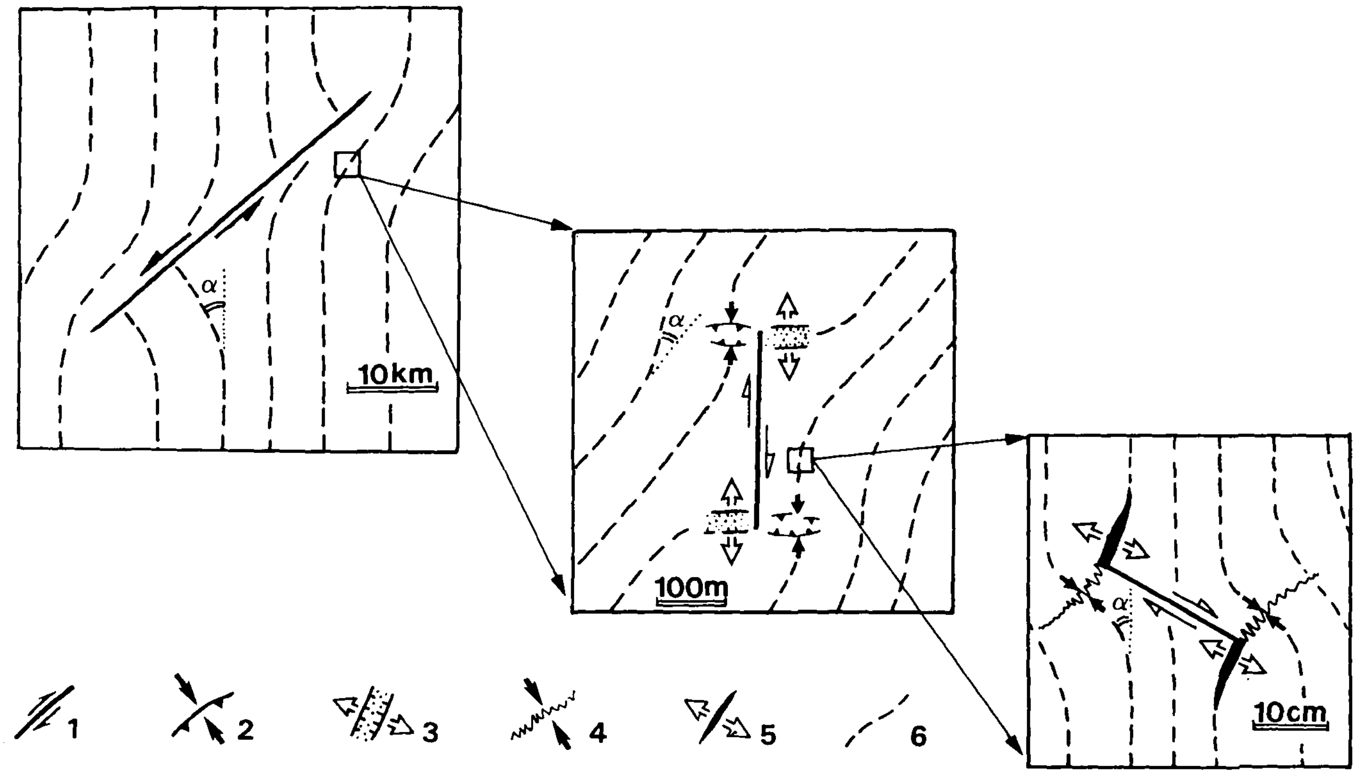

Figure 3. Example of stress deviations at different scales; 1—strike-slip fault; 2—reverse fault and S_{hmax} direction; 3—graben and S_{hmin} direction; 4—stylolitic joint and S_{hmax} direction; 5—tension gash and S_{hmin} direction; and 6—S_{hmax} trajectories; α is the angular difference between the local stress direction and the average stress direction at the considered scale.

lithospheric scale structures such as subduction fronts and large strike-slip faults.

3 PRINCIPAL STRESS ORIENTATION INDICATORS

Different categories of geophysical as well as geological data permit determination of the approximate nature (state) and orientation of tectonic stress tensors acting on a given region: earthquake focal mechanisms, *in situ* stress measurements and young geological deformational features (geometry of tectonic structures, microtectonic observations, young volcanic alignments, etc.). These different kinds of data generally show that one of the principal axes of the stress tensor is approximately vertical (Anderson 1951). Thus, the orientation of the stress ellipsoid is defined by specifying the azimuth of one of the subhorizontal principal stress axes.

3.1 Earthquake focal mechanisms

Earthquake focal mechanisms have been commonly used to determine the direction of the fault slip and of the stress components at the earthquake foci. Such information has been used to determine the average orientàtion of the stress ellipsoid at regional scale. In this study, as a first approximation, it is considered that the compression (P) and tension (T) axes, obtained from fault plane solutions, can be identified for the greatest (S_{hmax}) and the least (S_{hmin}) principal stress directions (McKenzie 1969; Raleigh, Healy & Bredehoeft 1972; Smith 1977; Eaton 1979; Mercier *et al.* 1979; Zoback & Zoback 1980; Philip 1987; Gephart & Forsyth 1984). For Europe and the Mediterranean regions, 454 fault-plane solutions were compiled (Fig. 5) and for each one of them only the two axes which were closer to the horizontal plane were considered. Most of these fault-plane solutions correspond to single events and only a few were calculated from microearthquake composite solutions. We only consider the shallow crustal earthquake (10–30 km depth) with magnitudes greater than 3.0.

3.2 *In situ* stress measurements

In situ stress measurements permit the determination of both the orientation and magnitude of local tectonic stress at the surface or at various depths. These methods include hydraulic fracturing, break-outs, overcoring, and flat-jack procedures (Leeman 1968; Cox 1970; Haimson & Fairhurst 1970; Zoback, Healy & Roller 1977; Zoback, Tsukahara & Hickmann 1980; Babcock 1978; McGarr & Gay 1978). A total of 284 of the available *in situ* stress measurements were compiled (Fig. 6). Most of these data were determined by hydraulic fracturing and overcoring. The data also include unpublished measurements on stress field orientation, such as those calculated from flat-jack measurements in dam tunnels made by E.D.F. (Electricité de France) and breakouts in G.D.F. (Gaz de France) wells in many localities of France.

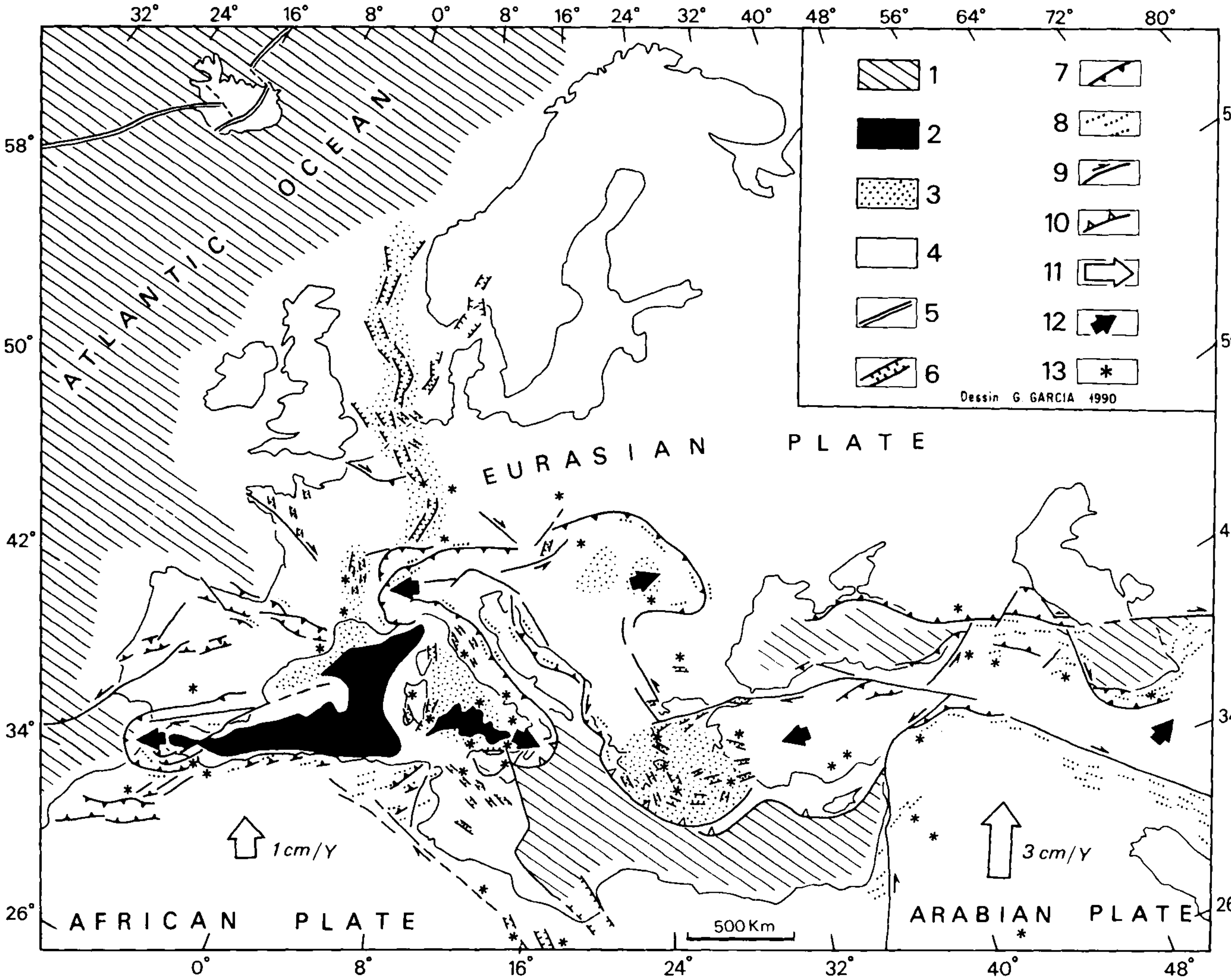

Figure 4. Present-day geodynamic map; subduction and continental collision zones in the Mediterranean and surrounding area. 1—Oceanic or thinned continental crust of Mesozoic age; 2—oceanic crust of Cenozoic age; 3—thinned continental crust; 4—continental crust; 5—oceanic ridge; 6—grabens; 7—thrust and reverse fault; 8—fold; 9—strike-slip fault; 10—subduction trench; 11—relative motion of Africa and Arabia with respect to Eurasia; 12—block movements with respect to the Eurasian platform; and 13—quaternary volcanoes.

3.3 Geologic data

Geologic information on principal stress orientations includes microtectonic measurements and alignments of young (quaternary) volcanic feeders (dikes and adventive volcanoes).

3.3.1 Microtectonic measurements

Numerical microtectonic methods have been proposed for reconstructing stress orientations at outcrop scale from microstructural observations such as striated fault planes, striated pebbles, tension gashes and stylolites (Carey & Brunier 1974; Angelier 1975, 1979, 1984; Carey 1976; Armijo & Cisternas 1978; Etchecopar, Vasseur & Daignières 1981; Angelier *et al.* 1982; Gephart & Forsyth 1984; Michael 1984). Besides the orientation of the principal stress tensor axes, these methods supply additional information such as the stress ellipsoid form ratio.

3.3.2 Young volcanic feeders

Within a rock mass, dike intrusions follow planes that are perpendicular to the least principal stress axis (Anderson 1951; Odé 1956; Yoder 1976). Thus, dikes and cinder cone alignments are considered as geologic indicators of the average principal stress orientation at regional scale (Nakamura 1977; Zoback *et al.* 1980, 1989).

For Europe and the Mediterranean region, 396 of these available data were selected, including 276 microtectonic reduced stress tensors and 120 young volcanic alignments (Fig. 7).

4 STRESS INDICATOR DATA BASE

Table 1 gives a detailed description of data compiled for the three types of principal stress indicators. Stress directions corresponding to each kind of data have been plotted on

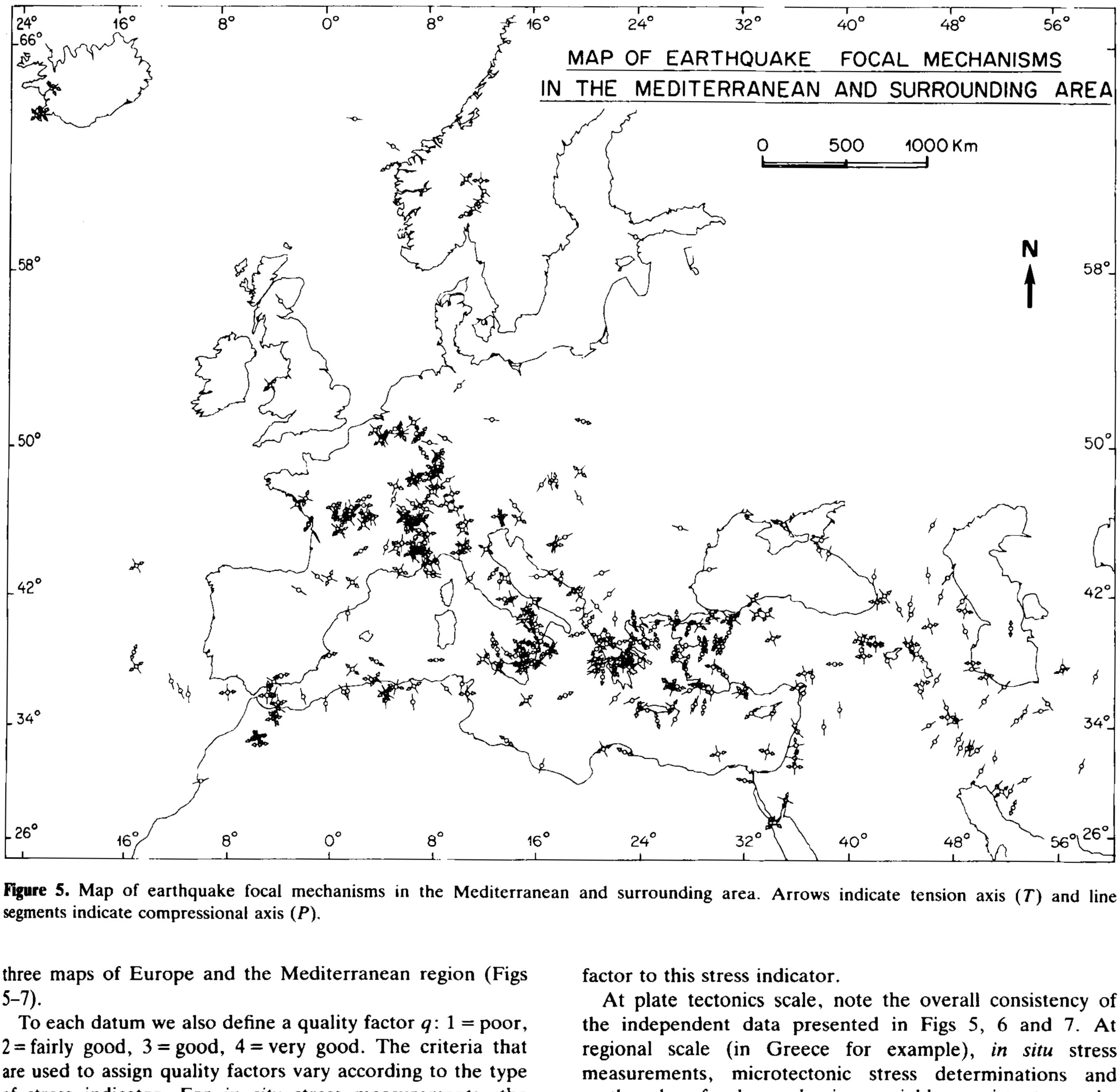

Figure 5. Map of earthquake focal mechanisms in the Mediterranean and surrounding area. Arrows indicate tension axis (T) and line segments indicate compressional axis (P).

three maps of Europe and the Mediterranean region (Figs 5–7).

To each datum we also define a quality factor q: 1 = poor, 2 = fairly good, 3 = good, 4 = very good. The criteria that are used to assign quality factors vary according to the type of stress indicator. For *in situ* stress measurements, the quality depends upon the specific technique that is dealt with and of the number of tests. As an example, hydraulic fracturing, break-outs and overcoring are more reliable than flat-jack methods (at least for principal stress directions). For stress orientation determined from inverse methods applied to microfault populations, the quality depends on the number of fault planes, their distribution in space and on criteria such as: (a) the distribution of fault planes in the histogram of angular differences between calculated and measured striations and (b) the mechanical reliability of the solution in terms of friction laws. For focal mechanisms the quality depends on the number and distribution of stations with respect to the focus, as well as on the magnitude of the earthquake. However, the additional uncertainty inherent in the approximation of the principal directions σ_1 and σ_3 by the P and T axes leads us to attribute a smaller quality factor to this stress indicator.

At plate tectonics scale, note the overall consistency of the independent data presented in Figs 5, 6 and 7. At regional scale (in Greece for example), *in situ* stress measurements, microtectonic stress determinations and earthquake focal mechanisms yield consistent results (Mercier *et al.* 1979, 1983). Furthermore, a good correspondence is generally observed between the stress orientations inferred from focal mechanisms which commonly sample a depth range between 5 and 15 km and the geologic and *in situ* stress indicators which sample the two uppermost kilometers. This implies a relatively uniform stress field throughout the upper crust (<15 km), as noted by Zoback & Zoback (1980); Philip & Meghraoui (1983) for the 1980 El Asnam earthquake or by Philip *et al.* (1992) for the 1988 Armenian earthquake. These observations lead us to use both near-surface stress field data and shallow earthquake stress data for the interpolation of the tectonic stress field.

In Fig. 8 all the compiled stress data indicators are shown. From this data base and from geodynamic criteria (Fig. 4), four types of zone have been defined according to their

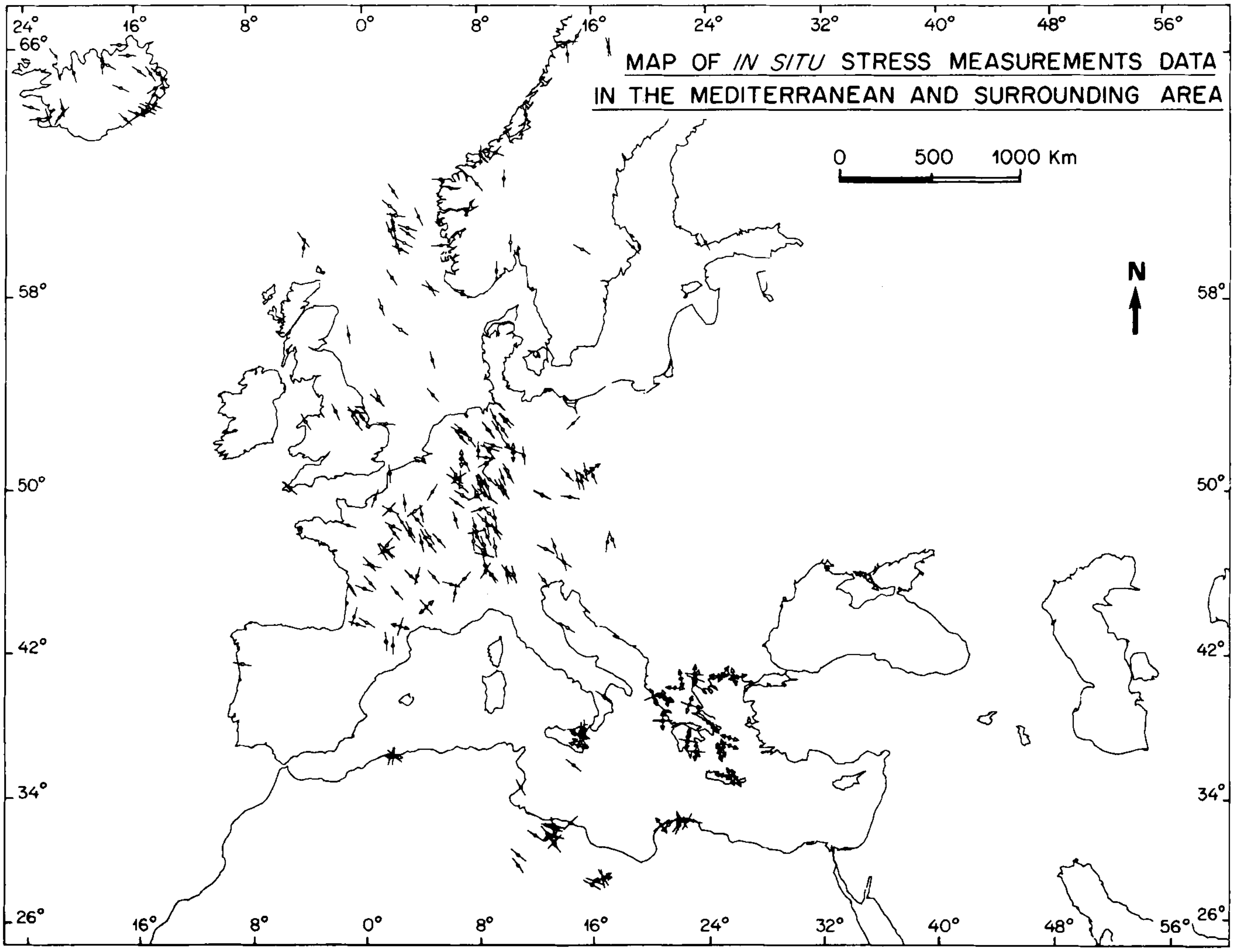

Figure 6. Map of *in situ* stress measurements in the Mediterranean and surrounding area. Arrows indicate S_{hmin} direction and line segments indicate S_{hmax} direction.

tectonic regimes:

The first type is characterized by reverse and strike–slip faults ($S_{hmax} = \sigma_1$; $S_{hmin} = \sigma_2$ or σ_3).

The second one associates normal and strike–slip faults ($S_{hmax} = \sigma_2$ or σ_1; $S_{hmin} = \sigma_3$).

The third type, localized in the back arcs of the Aegean and Tyrrhenean subduction zones, is very close to radial extension ($S_h = \sigma_2 = \sigma_3$).

The last type of zone corresponds to regions in which the tectonic regime is not well known.

Notice that in each case the S_{hmax} and/or S_{hmin} directions are quite continuous at this scale. From this data base, recent and present-day tectonic stress trajectories have been determined in each of the previously defined zones using a linear interpolation method.

5 METHODOLOGY FOR CONSTRUCTION OF AVERAGE TECTONIC STRESS DIRECTIONS AT A GIVEN SCALE

This section attempts to develop a simple numerical approach to calculate the average S_{hmax} or S_{hmin} directions at a given scale, from different kinds of stress indicators. The method that is proposed can be subdivided into three different steps (Fig. 9):

(1) Construction of a triangular element grid from the stress data map. The choice of grid nodes is determined according to the distribution of data. In high data density zones, nodes are centred on each data cluster. Conversely, in poorly sampled zones, node location coincides with isolated stress indicators.

(2) Calculation of the average S_{hmax} direction for each grid node, from stress data situated in the vicinity of this node. As will be explained below, the scale and the quality of data are taken into account in the determination of the average values.

(3) Linear interpolation inside each triangular element, from the average values defined on the grid nodes.

The size of triangular elements is selected according to the scale of directional deviations to be observed. Thus, in areas where small amplitude directional variations are to be examined, the size of triangular elements should be quite small. Conversely, in areas where the interest is placed on the average directions at a larger scale and small amplitude directional variations are to be smoothed, then triangular elements should be bigger. Preferably, the three sides of

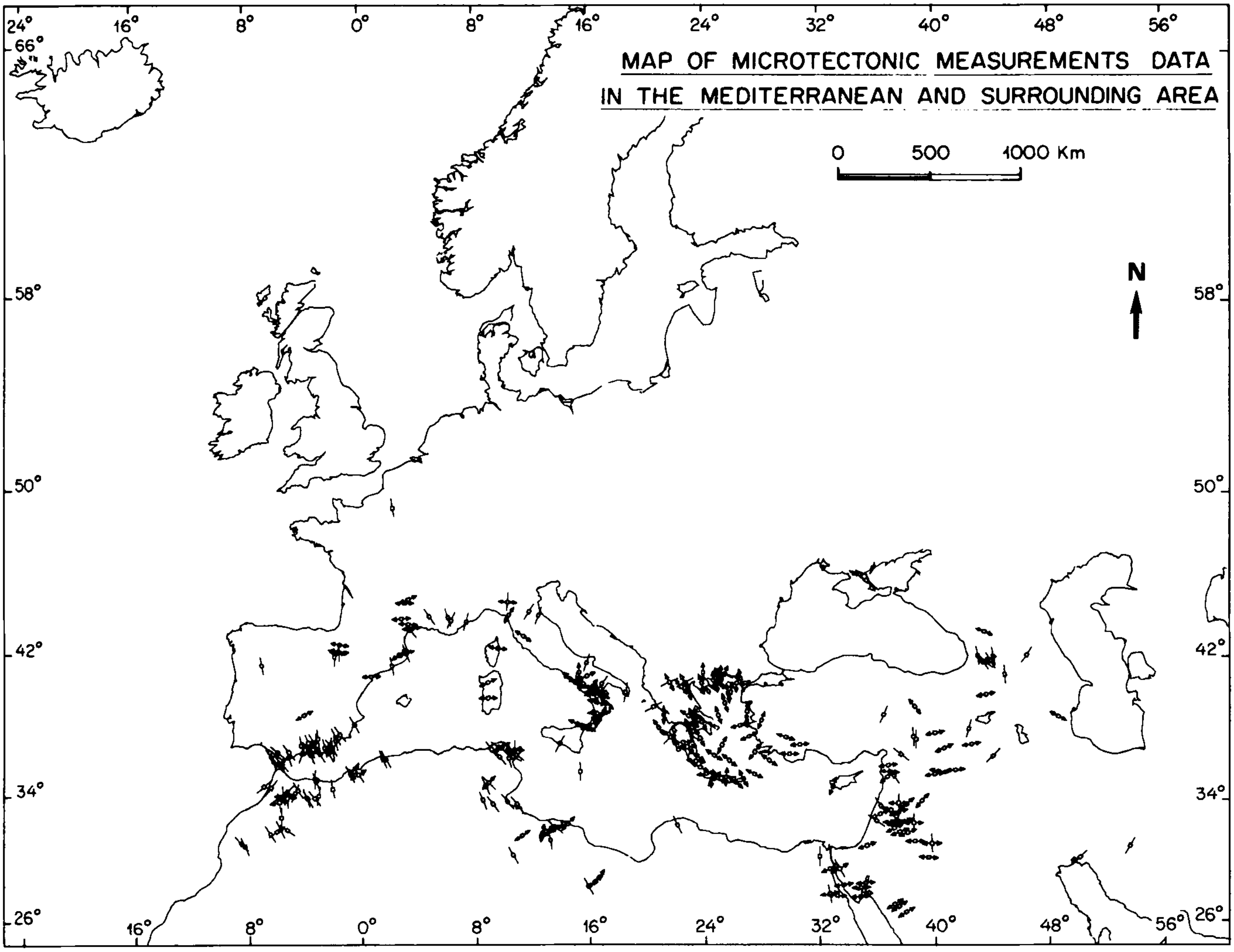

Figure 7. Map of quaternary microtectonic measurements in the Mediterranean and surrounding area. Arrows indicate S_{hmin} direction and line segments indicate S_{hmax} direction.

Table 1. Stress indicator data base; Nu—datum number; Lat—latitude N (°); Long—longitude E (°); Az1—azimuth of maximum horizontal stress axis (S_{hmax}); Az3—azimuth of minimum horizontal stress axis (S_{hmin}); Q—quality of stress data; CT—stress regime (E—extensional, D—strike slip, C—compressional); TD—type of data (S—earthquake focal mechanism, M—microtectonic, V—young volcanic alignment, I—*in situ* stress measurement).

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
1	50.800	3.600	322.	231.	2	D	S	Ahorner & al.,1972
2	50.480	4.080	217.		2	C	S	Idem.
3	50.450	4.280	18.		2	E	S	Idem.
4	50.450	4.230	147.		3	C	S	Idem.
5	50.330	4.020	325.	60.	3	D	S	Godefroy,1978a
6	50.660	5.580	60.	165.	2	D	S	Ahorner,1967.
7	49.700	7.250	325.		2	E	S	Ahorner & Schneider,1974
8	49.610	8.360	127.	37.	3	D	S	Idem.
9	49.510	8.360	321.	61.	4	D	S	Idem.
10	49.310	8.430	329.		3	E	S	Idem.
11	48.960	8.330	140.		3	E	S	Idem.
12	48.880	8.010	295.		2	E	S	Idem.
13	48.830	8.200	334.	72.	3	D	S	Idem.
14	48.610	8.210	319.	70.	4	D	S	Idem.
15	48.380	7.710	154.	56.	1	D	S	Idem.
16	47.950	8.260	187.	86.	4	D	S	Idem.
17	47.710	7.880	310.	41.	4	D	S	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
18	48.620	7.800	1.	115.	4	D	S	Delhaye,1976.
19	48.460	6.570	162.	225.	4	D	S	Idem.
20	48.430	6.500	167.	74.	4	D	S	Idem.
21	48.430	6.560	324.	62.	4	D	S	Godefroy,1978a.
22	48.180	6.600	332.	68.	3	D	S	Delhaye,1977.
23	47.980	5.150	22.	115.	1	D	S	Godefroy,1978a.
24	47.310	5.000	203.		3	C	S	Idem.
25	47.150	7.870	123.		3	C	S	Idem.
26	47.000	7.000	328.	238.	2	D	S	Pavoni,1977a.
27	47.100	6.450	306.		3	C	S	Delhaye,1976.
28	46.840	5.730	120.		3	C	S	Godefroy,1978a.
29	46.550	5.700	134.		4	C	S	Pavoni & Peterschmitt,1974
30	46.350	5.700	315.	54.	4	D	S	Idem.
31	46.310	6.790	229.		3	E	S	Frechet,1978.
32	46.200	7.180	317.	47.	3	D	S	Pavoni,1977b.
33	46.200	7.120	140.	50.	3	D	S	Idem.
34	45.980	6.350	264.	353.	4	D	S	Frechet,1978.
35	46.040	6.020	106.	199.	4	D	S	Idem.
36	45.270	6.670	41.		2	C	S	Idem.
37	44.900	6.500	206.		3	C	S	Idem.
38	44.960	5.630	183.	278.	4	D	S	Idem.
39	44.700	6.460	162.		3	C	S	Idem.
40	44.890	6.930	46.		3	C	S	Idem.
41	44.600	6.900	322.	232.	2	D	S	Idem.
42	44.380	6.400	352.	248.	2	D	S	Idem.
43	44.380	6.350	70.		3	C	S	Idem.
44	36.560	6.550	329.	62.	4	D	S	Bonnif & al.,1987.
45	44.530	6.780	28.	290.	3	D	S	Frechet,1978.
46	44.370	7.140	175.		4	C	S	Idem.
47	44.310	7.600	193.		2	C	S	Idem.
48	44.730	4.430	198.		3	C	S	Delhaye,1976.
49	44.530	2.530	58.		3	E	S	Idem.
50	43.000	0.160	292.	26.	3	D	S	Cisternas & al.,1978.
51	43.090	-0.760	132.		4	C	S	Gagnepain & al., 1980.
52	46.000	-1.440	25.		4	E	S	Courtot,1974.
53	45.950	-1.440	34.		3	E	S	Delhaye,1976.
54	45.720	0.810	130.	40.	4	D	S	Godefroy,1978a.
55	45.600	1.000	149.	37.	3	D	S	Godefroy,1978b.
56	46.650	0.670	30.		3	E	S	Delhaye,1976.
57	46.560	0.600	4.		3	E	S	Idem.
58	46.540	0.600	138.		3	C	S	Idem.
59	46.420	1.360	88.		2	C	S	Idem.
60	46.230	1.210	88.		3	E	S	Idem.
61	46.310	1.450	237.		3	C	S	Idem.
62	46.270	1.660	143.	237.	4	D	S	Idem.
63	46.500	1.700	38.		4	E	S	Idem.
64	46.690	1.730	244.		2	E	S	Idem.
65	46.710	1.330	187.		4	C	S	Idem.
66	47.010	0.490	69.		4	E	S	Idem.
67	46.890	1.820	163.	253.	4	D	S	Idem.
68	47.010	2.760	270.		4	E	S	Idem.
69	47.350	2.740	69.		4	E	S	Idem.
70	46.530	2.930	10.	100.	4	D	S	Godefroy,1978a
71	46.360	3.220	172.	82.	4	D	S	Delhaye,1976.
72	46.290	3.430	158.		3	C	S	Idem.
73	46.400	2.700	344.		2	E	S	Idem.
74	45.970	2.740	133.	247.	2	D	S	Idem.
75	47.060	-2.280	237.	333.	1	D	S	Idem.
76	47.370	-1.660	288.	192.	4	D	S	Idem.
77	45.440	7.580	172.	77.	4	D	S	Bossolasco & al.,1972.
78	43.300	8.010	105.		4	C	S	Mckenzie,1972.
79	43.150	8.000	105.		3	C	S	Bossolasco & al.,1974.
80	44.450	9.920	177.	60.	4	D	S	Bossolasco & al.,1973.
81	44.800	10.300	14.	278.	4	D	S	Bossolasco & al.,1974.
82	45.680	10.200	40.	307.	2	D	S	Di Filippo & al.,1962.
83	46.100	10.460	166.	51.	3	D	S	Idem.
84	46.420	13.030	353.	262.	4	D	S	Idem.
85	44.630	12.010	212.	119.	1	D	S	Caloi & al.,1970.
86	38.900	17.000	40.	130.	2	D	S	Riuscetti & Schik,1975.
87	38.000	15.500	283.		3	E	S	Idem.
88	37.800	14.700	225.	315.	2	D	S	Idem.
88	37.800	14.700	275.	180.	4	D	S	Idem.
89	35.700	15.100	321.	52.	2	D	S	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
90	38.600	15.200	75.		4	E	S	Idem.
91	37.900	13.100	179.		1	C	S	Mckenzie,1972.
91	37.700	13.000	136.		1	C	S	Riuscetti & Schik,1975.
92	47.600	9.400	346.	76.	4	D	S	Mayer Rosa & Pavoni,1977.
93	47.100	9.000	158.	68.	4	D	S	Idem.
94	46.800	9.700	156.	66.	1	D	S	Idem.
95	46.800	7.500	124.		1	C	S	Idem.
97	36.710	10.170	187.		1	C	S	Hatzfeld,1978.
98	36.520	5.210	194.	102.	1	D	S	Idem.
90	36.140	4.470	330.		1	C	S	Idem.
100	36.160	4.400	154.	246.	1	D	S	Idem.
101	35.700	4.400	174.		1	C	S	Mckenzie,1972.
102	36.250	1.530	172.		3	C	S	Idem.
103	35.500	-0.100	178.		1	C	S	Idem.
104	35.920	-1.830	160.		3	C	S	Hatzfeld,1978.
105	35.570	-3.710	350.	80.	3	D	S	Frogneux,1980.
106	36.010	-4.580	358.	90.	1	D	S	Hatzfeld,1978.
107	34.560	-4.050	347.	257.	2	D	S	Idem.
108	36.860	-4.060	121.	226.	4	D	S	Idem.
109	36.100	-10.600	176.		2	C	S	Udias & al.,1976.
109	36.100	-10.600	176.		4	C	S	Cagnetti & al.,1976.
110	47.000	14.200	140.		4	C	S	Udias & al.,1976.
110	36.200	-7.600	174.	306.	4	D	S	Mckenzie,1972.
111	35.600	6.500	173.		1	C	S	Udias & al.,1976.
112	47.000	14.200	143.		1	C	S	Cagnetti & al.,1976.
113	46.270	14.530	30.	232.	2	D	S	Idem.
115	45.270	18.040	62.		4	C	S	Idem.
116	44.920	17.230	194.		1	C	S	Mckenzie,1972
117	43.310	16.940	239.		3	C	S	Idem.
118	43.000	10.800	217.		4	C	S	Mckenzie,1978.
119	42.100	21.400	226.		3	C	S	Mckenzie,1972.
120	38.900	20.440	222.		2	C	S	Mckenzie,1978.
121	38.280	20.280	240.		4	C	S	Idem.
122	38.110	20.720	65.		3	C	S	Mckenzie,1972.
123	37.800	20.560	235.		1	C	S	Idem.
124	37.560	20.280	240.		4	C	S	Idem.
125	37.160	20.900	6.		1	E	S	Idem.
126	37.700	21.800	178.		4	E	S	Idem.
127	38.090	21.980	136.		2	E	S	Mckenzie,1978.
128	38.430	22.660	187.		3	E	S	Idem.
129	39.100	21.700	118.		3	C	S	Mckenzie,1972.
130	35.810	21.840	223.		2	C	S	Mckenzie,1978.
131	35.120	23.610	16.		2	E	S	Idem.
132	35.700	23.130	68.		2	C	S	Mckenzie,1972.
133	37.200	30.300	338.		4	C	S	Klein & al.,1977.
134	35.340	27.770	199.		2	C	S	Idem.
135	35.490	27.960	199.		3	C	S	Idem.
136	36.180	29.200	191.		3	C	S	Mckenzie,1978.
137	36.450	26.230	20.	285.	2	D	S	Mckenzie,1972.
138	35.290	28.590	190.		1	E	S	Idem.
139	36.450	28.590	134.		2	E	S	Idem.
140	36.560	26.560	284.		1	E	S	Idem.
141	36.690	25.810	139.		1	E	S	Idem.
142	37.660	27.190	354.		1	E	S	Idem.
143	37.590	21.760	144.		3	E	S	Mckenzie,1978.
144	37.800	29.300	11.	191.	2	D	S	Mckenzie,1972.
145	33.100	13.600	307.		3	E	S	Klein & al.,1977.
146	38.590	28.450	205.		2	E	S	Mckenzie,1972.
147	39.030	29.740	18.		2	E	S	Mckenzie,1978.
148	39.030	30.000	197.		2	E	S	Idem.
149	39.200	29.570	218.		2	E	S	Idem.
150	39.860	30.490	203.		2	E	S	Mckenzie,1972.
151	39.280	29.420	9.		3	E	S	Mckenzie,1978.
152	39.130	28.700	171.		3	E	S	Idem.
153	39.160	28.580	6.		3	E	S	Mckenzie,1972.
154	39.180	28.370	248.	10.	3	D	S	Idem.
155	40.660	30.890	312.	43.	1	D	S	Idem.
156	40.700	30.800	48.		1	E	S	Idem.
157	40.700	30.400	146.	45.	1	D	S	Idem.
158	40.300	28.200	32.	212.	3	D	S	Idem.
159	40.070	27.390	15.		1	E	S	Idem.
160	40.420	26.140	247.	338.	4	D	S	Idem.
161	40.500	25.000	264.		1	C	S	Idem.

Table 1. *(continued)*

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
162	32.400	22.600	295.		3	E	S	Klein & al.,1977.
163	39.200	24.600	317.	199.	3	D	S	Idem.
164	39.400	24.000	85.	355.	4	D	S	Idem.
165	38.210	8.210	267.		3	E	S	Gasparini & al,1982.
166	43.410	5.510	203.	23.	4	D	S	Haessler& al.,1985
167	44.220	6.510	318.		4	C	S	Ménard & Frechet,1990
168	44.250	7.420	19.		4	C	S	Idem.
169	44.520	7.340	99.		2	E	S	Idem.
170	44.980	7.370	185.		4	E	S	Idem.
171	45.110	37.500	66.		4	C	S	Idem.
172	45.650	6.910	110.		2	C	S	Idem.
173	45.790	6.350	310.	130.	4	D	S	Idem.
174	46.160	6.400	232.		2	E	S	Idem.
175	46.310	6.790	196.	29.	2	D	S	Idem.
176	46.400	5.800	313.	52.	2	D	S	Pavoni & Peterschmitt,1974.
177	44.670	5.190	243.	341.	2	D	S	Ménard & Frechet,1990
178	36.060	4.470	293.	23.	2	D	S	Hatzfeld,1978.
179	36.160	4.400	154.	246.	2	D	S	Idem.
180	35.240	-3.730	304.	35.	2	D	S	Idem.
181	34.870	-3.900	206.		2	E	S	Idem.
182	36.020	-4.070	202.		2	C	S	Idem.
183	36.400	-4.420	169.		1	E	S	Idem.
184	38.490	0.130	251.		3	E	S	Idem.
185	37.620	1.880	40.	140.	2	D	S	Mezcua & al.,1978.
186	38.100	3.700	301.		3	E	S	Udias & al.,1976.
187	37.000	3.300	276.		1	E	S	Idem.
188	37.000	3.600	301.	74.	1	D	S	Idem.
189	36.100	10.600	176.	73.	3	D	S	Idem.
190	34.440	47.800	167.		3	C	S	Jackson & Mckenzie,1984.
191	34.090	45.670	236.		3	C	S	Mckenzie,1972.
192	33.050	46.120	31.		2	C	S	Chandra,1984.
193	36.980	46.250	209.		2	C	S	Jackson & Mckenzie,1984.
194	33.200	47.940	29.		3	C	S	Idem.
195	32.640	48.080	206.		3	C	S	Jackson & Fitch,1981.
196	32.590	48.580	204.		3	C	S	Ni & Barazangi,1986.
197	32.680	48.780	183.		2	C	S	Mckenzie,1972.
198	32.660	48.920	200.		2	C	S	Jackson & Mckenzie,1984.
199	32.490	49.340	230.		2	C	S	Ni & Barazangi,1986.
200	31.140	49.640	30.		2	C	S	Jackson & Mckenzie,1984.
201	31.990	50.700	185.		2	C	S	Iddem.
202	30.090	50.870	222.		3	C	S	Jackson & Fitch,1981.
203	29.760	51.240	140.	28.	3	D	S	Chandra,1984.
204	29.800	51.910	205.		3	C	S	Jackson & Mckenzie,1984.
205	28.710	52.120	22.		3	E	S	Idem.
206	30.530	53.000	61.		2	C	S	Mckenzie,1972.
207	35.040	54.220	257.		1	C	S	Sengör & Kidd,1979.
208	34.400	52.350	42.		2	C	S	Mckenzie,1972.
209	36.140	36.140	22.		2	C	S	Sengör & Kidd,1979.
210	36.550	51.400	43.		2	C	S	Idem.
211	37.180	50.000	167.	258.	2	D	S	Idem.
212	34.650	47.100	180.	271.	2	D	S	Idem.
213	35.250	47.000	158.		2	C	S	Idem.
214	34.350	47.650	71.		2	C	S	Idem.
215	36.250	45.000	158.		2	C	S	Idem.
216	38.470	40.720	358.	92.	2	D	S	Mckenzie,1972.
217	38.200	42.500	154.		1	C	S	Sengör & Kidd,1979.
218	44.720	10.310	209.		1	C	S	Jackson & Mckenzie,1984.
219	40.250	45.750	345.	95.	4	D	S	Mckenzie,1972.
220	38.830	40.520	187.		4	C	S	Sengör & Kidd,1979.
221	51.250	19.400	106.		4	E	S	Gibowicz & al.,1982.
222	51.330	12.460	97.		1	C	S	Grässl & &al.,1984
223	39.200	41.600	357.	266.	3	D	S	Mckenzie,1972.
224	34.100	35.500	155.		4	C	S	Ben Menahem & al.,1976
225	37.200	36.800	180.		4	C	S	Idem.
226	41.250	43.400	337.		3	C	S	Sengör & Kidd,1979.
227	42.000	42.300	142.	43.	3	D	S	Idem.
228	35.100	24.300	102.		3	C	S	Mckenzie,1972.
229	39.200	21.200	304.		3	C	S	Idem.
230	37.830	20.600	209.		3	C	S	Jackson & al.,1981.
231	43.100	41.500	188.		3	C	S	Mckenzie,1972.
232	44.400	38.050	200.		3	C	S	Jackson & Mckenzie,1984.
233	44.600	37.300	338.		3	C	S	Mckenzie,1972.
234	41.790	32.310	306.	170.	3	D	S	Alptekin & al.,1986.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
235	43.500	29.000	78.		3	C	S	Idem.
236	41.680	41.750	3.	220.	3	D	S	Idem.
237	37.600	55.830	68.		4	E	S	Jackson & Fitch,1979.
238	37.820	55.880	179.		2	C	S	Jackson & Mckenzie,1984.
239	35.500	54.750	140.		3	C	S	Abdalian,1953.
241	35.630	49.870	216.		3	C	S	Mckenzie,1972.
242	37.670	48.900	78.		3	C	S	Berberian,1982 and 1983.
243	43.170	45.600	174.		3	C	S	Jackson & Mckenzie,1984.
244	47.090	47.090	40.		2	C	S	Idem.
245	47.080	47.080	41.		3	C	S	Idem.
246	45.930	45.930	210.		3	C	S	Idem.
247	41.960	46.550	198.		3	C	S	Idem.
248	41.700	48.200	41.		3	C	S	Mckenzie,1972.
249	41.540	44.240	190.		3	C	S	Jackson & Mckenzie,1984.
250	41.140	48.390	10.	190.	3	D	S	Idem.
251	39.930	48.420	160.		1	C	S	Idem.
252	38.050	48.990	270.		3	E	S	Idem.
253	36.770	45.130	167.	270.	3	D	S	Idem.
254	38.590	44.710	212.	114.	2	D	S	Idem.
255	39.200	44.300	189.	280.	3	D	S	Mckenzie,1972.
256	39.100	44.030	339.		3	C	S	Jackson & Mckenzie,1984.
257	39.120	41.600	274.		3	E	S	Mckenzie,1972.
258	27.670	33.990	40.	220.	3	D	S	Huang & Solomon,1987.
259	39.400	40.900	329.	238.	3	D	S	Mckenzie,1972.
260	39.500	40.400	149.	57.	3	D	S	Idem.
261	38.930	44.380	351.		3	C	S	Idem.
262	43.100	41.500	303.		3	E	S	Idem.
263	27.650	33.650	212.		3	E	S	Jackson & Mckenzie,1984.
264	36.410	31.750	346.		3	E	S	Idem.
265	36.180	31.510	230.	50.	3	D	S	Idem.
266	36.240	31.340	255.		2	C	S	Idem.
268	37.590	29.760	143.	53	4	E	S	Mckenzie,1978.
269	40.900	29.200	137.	23.	4	D	S	Idem.
270	40.950	32.570	303.	36.	4	D	S	Mckenzie,1972.
271	40.960	33.410	122.	213.	4	D	S	Idem.
272	39.500	33.800	250.		3	E	S	Idem.
273	38.000	38.500	90.		3	E	S	Idem.
274	37.400	36.200	347.	114.	3	D	S	Idem.
275	30.500	31.700	283.		3	E	S	El Saïd Maamon,1976.
276	66.830	13.660	268.		1	C	S	Bungum & al.,1979.
277	29.200	34.800	110.	201.	3	D	S	Aboukaraki,1987
279	32.000	35.500	270.	90.	2	D	S	Ben Menahem & Vered,1976.
280	32.800	35.600	80.	349.	1	D	S	Idem.
281	33.700	35.700	316.		3	C	S	El Saïd Maamon,1976.
282	34.000	37.700	177.		3	C	S	Ben Menahem & Vered,1976.
283	35.120	38.900	177.		3	C	S	Rotstein & Kafla,1982.
285	36.500	35.700	164.	251.	1	D	S	Idem.
286	52.980	-4.430	319.	226.	2	D	S	Idem.
287	59.360	23.340	294.		3	C	S	Turbitt & al. ,1985.
288	56.750	-3.600	324.		3	C	S	Slunga,1979.
289	50.210	7.700	281.		3	C	S	Hedayati,1975.
290	50.630	6.710	190.		2	E	S	Ahorner & Schneider,1974.
291	50.630	7.100	215.		3	E	S	Pavoni & Peterschmitt,1974.
292	51.180	6.500	55.	235.	3	D	S	Ahorner,1975.
293	50.870	5.100	235.		3	E	S	Idem.
294	60.250	10.450	243.		2	E	S	Wessel & Husebye,1987.
295	60.450	11.000	117.	213.	2	D	S	Idem.
296	60.750	11.570	107.	201.	2	D	S	Idem.
297	61.120	11.820	134.		3	C	S	Idem.
298	61.500	11.570	181.	52.	3	D	S	Idem.
299	61.550	10.450	313.	43.	3	D	S	Idem.
300	34.900	32.200	49.		3	E	S	Mercier & al.,1973.
301	40.700	23.250	352.		3	E	S	Soufleris & Stewart,1981.
302	40.750	23.260	350.		4	E	S	Papazacho & al.,1979.
303	40.730	23.220	177.		4	E	S	Idem.
304	40.200	24.800	42.		4	E	S	Mckenzie,1972.
310	38.660	26.290	197.		4	E	S	Mckenzie,1972.
311	39.080	27.200	96.		3	C	S	Idem.
312	40.120	27.430	26.		3	E	S	Idem.
313	38.500	26.420	206.		3	E	S	Idem.
316	40.750	26.500	360.		2	E	S	Dewey & al.,1979.
317	40.300	28.200	32.	212.	4	D	S	Mckenzie,1972.
318	39.400	25.000	161.		3	E	S	Idem.

Table 1. *(continued)*

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
319	39.240	22.170	253.		4	E	S	Idem.
320	39.700	21.300	332.		3	E	S	Idem.
321	38.400	22.400	355.		3	C	S	Idem.
322	34.500	26.400	207.		3	C	S	Idem.
323	34.400	25.060	346.		3	E	S	Idem.
324	41.020	14.980	55.		3	E	S	Westaway,1987.
325	39.430	21.190	76.		3	E	S	Anderson & Jackson,1987a.
326	41.410	20.440	140.		4	C	S	Idem.
327	37.850	12.970	203.		3	C	S	Idem.
328	37.680	12.960	37.		3	C	S	Idem.
329	37.900	20.900	229.		3	C	S	Idem.
330	40.500	19.900	211.		3	E	S	Idem.
331	39.570	20.630	207.	333.	4	D	S	Idem.
332	44.870	17.280	2.	94.	3	D	S	Idem.
333	44.920	17.230	21.		3	C	S	Idem.
334	44.770	10.330	308.	196.	3	D	S	Idem.
335	38.280	20.340	261.		3	C	S	Idem.
336	46.350	13.270	168.		4	C	S	Idem.
337	37.560	20.350	262.		3	C	S	Idem.
338	37.540	20.550	205.		3	C	S	Idem.
339	46.280	13.150	166.		3	C	S	Idem.
340	46.290	13.200	181.		3	C	S	Idem.
341	46.300	13.190	155.		4	C	S	Idem.
342	46.320	13.130	172.		3	C	S	Idem.
343	38.390	15.060	18.		3	C	S	Schneider, 1979.
344	41.250	19.030	261.		3	C	S	Anderson & Jackson,1987a.
345	42.090	19.200	212.		3	C	S	Idem.
346	42.310	18.680	237.		3	C	S	Idem.
347	42.250	18.750	64.		3	E	S	Idem.
348	42.810	13.060	184.		3	C	S	Idem.
349	38.280	11.740	313.	222.	3	D	S	Idem.
350	43.290	20.830	249.		3	C	S	Idem.
351	38.480	14.250	279.		4	E	S	Idem.
352	40.760	15.330	250.	39.	3	D	S	Deschamps & King, 1983.
353	44.840	17.310	24.		3	C	S	Anderson & Jackson,1987a.
354	40.880	19.590	233.		3	C	S	Idem.
355	38.020	20.220	225.		3	C	S	Idem.
356	38.290	20.260	348.		3	E	S	Idem.
357	43.260	12.550	39.		3	E	S	Idem.
358	41.760	13.890	57.		3	E	S	Idem.
359	41.830	13.960	163.		3	C	S	Idem.
360	42.960	17.730	9.		3	E	S	Idem.
361	40.670	21.830	2.		3	C	S	Idem.
362	39.200	15.200	105.		4	E	S	Anderson & Jackson,1987b.
363	39.030	15.630	120.		3	E	S	Idem.
364	39.260	15.290	95.		4	E	S	Idem.
365	38.790	14.820	134.		3	E	S	Idem.
366	38.630	14.710	116.		3	E	S	Idem.
367	40.000	15.410	315.		3	C	S	Idem.
368	38.630	13.580	320.		3	C	S	Idem.
369	41.100	15.230	117.		3	E	S	Dziewonski & al.,1984.
370	39.410	12.520	357.		3	E	S	Idem.
371	34.550	-4.060	144.		3	E	S	Frogneux,1980.
372	32.890	5.090	266.		2	E	S	Ramdani & Tadili,1980.
373	33.300	5.250	140.		3	E	S	Idem.
374	33.290	5.270	173.		2	C	S	Idem.
375	33.330	5.250	68.		2	E	S	Idem.
376	33.330	5.280	243.	111.	2	D	S	Idem.
377	33.300	5.180	250.		2	E	S	Idem.
378	33.260	5.650	65.		2	E	S	Nicolas & al.,1990.
379	50.430	6.840	232.		2	E	S	Idem.
380	50.850	5.510	180.		3	E	S	Idem.
381	50.630	5.500	90.		3	C	S	Haessler,1985.
382	45.780	26.780	286.		3	C	S	Hartzell,1979.
383	48.270	17.010	180.		3	C	S	Pospisil,1985.
384	48.170	16.910	344.		3	C	S	Idem.
385	48.260	17.350	170.		3	E	S	Idem.
386	48.740	19.160	220.	345.	3	D	S	Idem.
389	42.750	1.900	41.	133.	3	D	S	Olivera & al.,1986.
390	42.320	-2.170	120.		3	C	S	Idem.
392	37.230	-3.530	257.		3	E	S	Vidal & al.,1982.
393	41.250	15.050	188.		3	C	S	Gasparini & al ,1982.
395	43.000	13.450	228.	129.	3	D	S	Idem.

Table 1. *(continued)*

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
396	38.440	12.120	337.		4	C	S	Idem.
397	36.000	18.080	68.		3	E	S	Idem.
398	40.700	15.500	10.		3	E	S	Idem.
399	41.650	15.730	327.	59.	3	D	S	Idem.
400	43.100	15.900	93.		3	C	S	Constantinescu & al.,1966.
401	36.200	1.250	325.		4	C	S	Mackenzie,1978.
402	35.180	23.800	229.		3	C	S	Idem.
403	35.290	26.230	301.	196.	3	D	S	Idem.
404	37.930	22.390	355.	91.	3	D	S	Mackenzie,1972.
405	36.300	27.500	245.		3	C	S	Idem.
406	38.600	22.400	235.		3	C	S	Idem.
407	38.200	23.700	219.		3	C	S	Idem.
408	37.800	22.900	353.		3	C	S	Idem.
409	36.600	28.300	179.	359.	3	D	S	Idem.
410	38.140	15.710	192.	292.	3	D	S	Gasparini & al.,1982.
411	50.410	8.870	299.		3	C	S	Leydecker & al.,1980.
412	32.600	21.000	333.	153.	3	D	S	El Saïd Maamoun,1976.
413	32.280	29.680	346.	78.	2	D	S	Idem.
414	52.940	9.940	43.		3	C	S	Gangl,1975.
415	38.100	16.030	117.	243.	3	D	S	Gasparini & al.,1982.
416	38.690	16.760	255.		3	E	S	Idem.
417	39.330	16.190	125.		3	E	S	Idem.
418	39.320	16.200	26.		3	C	S	Idem.
419	39.740	18.940	74.		3	E	S	Idem.
420	39.990	15.910	312.		2	E	S	Idem.
421	40.360	15.770	197.	34.	3	D	S	Idem.
422	37.920	14.570	194.	74.	3	D	S	Idem.
423	38.870	12.860	173.		3	E	S	Idem.
424	40.530	14.870	67.		3	C	S	Idem.
425	38.790	17.030	15.		3	E	S	Idem.
426	39.120	14.550	41.	251.	3	D	S	Idem.
427	8.580	39.300	125.		3	C	S	Moreira,1985.
428	43.700	-14.600	331.	171.	2	D	S	Idem.
429	36.900	-11.900	164.		3	C	S	Idem.
430	37.800	-14.600	325.	174.	3	D	S	Idem.
431	36.300	-11.200	335.		3	C	S	Idem.
432	38.700	-14.800	199.		2	E	S	Idem.
433	64.800	-21.200	294.		3	E	S	Einarsson & al.,1977.
434	64.750	-21.350	60.	160.	2	D	S	Idem.
435	63.860	-22.060	56.	153.	2	D	S	Klein & al.,1973.
436	63.900	-22.120	321.	51.	2	D	S	Idem.
437	63.900	-22.080	330.		2	E	S	Idem.
438	63.830	-22.650	137.		1	E	S	Idem.
439	63.840	-22.660	230.		1	E	S	Idem.
440	40.100	51.900	181.	14.	1	D	S	El Saïd Maamoun,1976.
441	30.500	-9.600	251.		1	C	S	Constantinescu & al.,1966.
442	36.400	9.000	318.		2	C	S	Idem.
443	48.300	9.100	57.		2	C	S	Idem.
444	47.400	19.100	329.		2	C	S	Idem.
445	32.400	33.400	15.	42.	2	D	S	Idem.
446	*43.860*	*7.760*	*160.*	*63.*	*3*	*D*	*S*	*Bethoux & al.,1988.*
447	43.930	7.710	159.	69.	3	D	S	Idem.
448	43.890	8.270	159.		3	C	S	Idem.
449	43.460	7.420	167.		3	C	S	Idem.
450	41.000	1.550	185.		3	C	S	Susagna & al.,1988.
451	40.940	44.290	207.		4	C	S	Cisternas & al.,1989.
452	62.750	4.900	303.		2	C	S	Hansen & al.,1989.
453	63.700	2.000	277.		2	C	S	Idem.
454	62.000	4.500	239.		2	E	S	Idem.
1	37.000	9.700	60.			E	M	Ben Ayed,1986.
2	36.900	9.900	49.		4	E	M	Idem.
3	37.200	10.200	145.		3	C	M	Idem.
4	36.850	10.600	0.	90.	3	D	M	Idem.
5	35.620	10.720	143.		3	C	M	Idem.
6	35.800	8.600	0.		4	C	M	Idem.
7	35.250	8.600	35.		3	C	M	Dlala, 1984.
8	35.000	8.800	134.	56.	3	D	M	Idem.
9	34.250	8.800	135.	45.	3	D	M	Ben Ayed,1986.
10	33.750	10.750	142.		3	C	M	Idem.
11	36.380	1.700	150.		4	C	M	Meghraoui,1982.
12	36.370	1.500	156.		4	C	M	Idem.
13	36.500	1.370	147.		4	C	M	Idem.
14	36.200	1.520	175.		4	C	M	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
15	34.100	-5.100	173.	86.	4	D	M	Ait Brahim & Chotin,1984.
16	33.870	-5.650	170.	81.	3	D	M	Idem.
17	34.250	-5.900	8.	106.	4	D	M	Idem.
18	34.270	-5.350	173.	88.	4	D	M	Idem.
19	34.650	-1.970	169.		3	C	M	Andries,1987.
20	31.600	-7.970	130.		4	C	M	Ferrandini & Petit,1984.
21	31.250	-8.000	155.		4	C	M	Dutour & Ferrandini,1985.
20	31.430	-8.250	136.		4	C	M	Petit & al.,1985.
22	35.680	-0.460	113.	30.	3	D	M	Morel & al.,1981.
23	35.500	-0.760	152.		3	C	M	Idem.
24	35.250	-3.180	1.		4	C	M	Idem.
25	35.000	-3.250	155.		4	C	M	Idem.
26	34.090	-3.190	141.		4	C	M	Idem.
27	34.000	-3.260	148.		3	C	M	Idem.
28	33.910	-3.360	151.		4	C	M	Idem.
29	34.070	-3.650	150.		4	C	M	Idem.
30	34.160	-3.550	168.		4	C	M	Idem.
31	34.140	-3.750	161.		3	C	M	Idem.
32	34.580	-4.350	149.		3	C	M	Idem.
33	34.420	-4.550	21.		4	C	M	Idem.
34	34.590	-4.820	55.		3	C	M	Idem.
35	34.500	-5.100	47.		3	C	M	Idem.
36	34.200	-5.600	53.		3	C	M	Idem.
37	34.490	-5.610	51.		4	C	M	Idem.
38	34.720	-6.200	36.		4	C	M	Idem.
39	34.800	-6.700	49.		4	C	M	Idem.
40	33.820	-6.900	51.		4	C	M	Idem.
41	36.120	-5.470	139.		4	C	M	Idem.
42	36.100	-5.800	141.		4	C	M	Idem.
43	35.080	-3.110	159.		4	C	M	Frizon,1979.
44	34.240	-2.930	10.		4	C	M	Guillemin,1976.
45	36.870	8.890	141.		3	C	M	Schäfer,1980.
46	36.890	9.000	142.		3	C	M	Idem.
47	37.000	9.500	124.		3	C	M	Idem.
48	36.980	9.480	142.		3	C	M	Idem.
49	36.880	9.520	122.		3	C	M	Idem.
50	36.900	10.200	142.		3	C	M	Idem.
51	36.820	10.250	151.		3	C	M	Idem.
52	36.500	10.490	120.		3	C	M	Idem.
53	36.590	10.480	110.		3	C	M	Idem.
54	36.600	10.700	125.		3	C	M	Idem.
55	36.400	10.190	163.		3	C	M	Idem.
56	36.490	9.550	140.		3	C	M	Idem.
57	36.470	9.400	117.		3	C	M	Idem.
58	34.800	8.590	155.		3	C	M	Idem.
59	34.000	8.420	157.		3	C	M	Idem.
60	33.980	8.390	157.		3	C	M	Idem.
61	33.750	9.100	142.		3	C	M	Idem.
62	33.700	9.000	142.		3	C	M	Idem.
63	33.900	10.100	139.		3	C	M	Idem.
64	33.750	10.110	152.		3	C	M	Idem.
65	31.900	11.120	54.		2	E	M	Idem.
66	30.700	10.500	150.		2	C	M	Idem.
67	32.040	12.500	12.		2	E	M	Idem.
68	32.000	12.710	49.		2	E	M	Idem.
69	32.150	12.750	50.		2	E	M	Idem.
70	32.100	13.000	124.		2	C	M	Idem.
71	32.180	13.100	52.		2	E	M	Idem.
72	32.250	13.110	160.		2	C	M	Idem.
73	32.370	13.120	45.		2	E	M	Idem.
74	32.400	13.400	132.		2	C	M	Idem.
75	32.100	13.600	53.		2	E	M	Idem.
76	32.600	14.250	43.		2	E	M	Idem.
77	31.600	13.050	171.		2	C	M	Idem.
78	28.800	15.650	152.		2	C	M	Idem.
79	29.000	15.750	152.		2	C	M	Idem.
80	29.100	16.100	53.		2	E	M	Idem.
81	29.370	16.370	35.		2	E	M	Idem.
82	32.500	21.750	155.		2	C	M	Idem.
83	32.820	21.920	124.		2	C	M	Idem.
84	32.750	35.500	126.		2	C	M	Arthaud & al.,1978.
85	33.590	35.800	145.		2	C	M	Idem.
86	33.400	36.200	132.		2	C	M	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
87	33.380	36.500	112.		4	C	M	Idem.
88	34.550	36.490	114.		4	C	M	Idem.
89	35.300	36.250	48.		4	E	M	Idem.
90	35.350	36.700	146.		4	C	M	Idem.
91	36.420	36.600	123.		4	C	M	Idem.
92	36.580	37.190	128.		4	C	M	Idem.
93	37.550	21.260	43	135.	3	D	M	Mercier & al.,1973.
94	35.200	24.120	7.		3	E	M	Angelier,1979.
95	35.190	24.260	41.		4	E	M	Mercier,1981.
96	35.210	24.750	121.		4	E	M	Idem.
98	37.000	22.400	85.		4	E	M	Idem.
99	37.250	22.140	85.		4	E	M	Idem.
100	37.620	22.200	87.		4	E	M	Idem.
101	37.620	21.500	0.		4	E	M	Idem.
102	38.100	22.480	160.		4	E	M	Idem.
103	37.870	22.800	10.		4	E	M	Idem.
104	37.500	23.300	154.		4	E	M	Idem.
105	38.120	23.300	126.		4	E	M	Idem.
106	38.750	22.500	123.		4	E	M	Idem.
107	38.700	22.800	156.		4	E	M	Idem.
108	38.680	23.000	170.		4	E	M	Idem.
109	38.400	23.400	149.		4	E	M	Idem.
110	40.550	21.200	64.	152.	4	D	M	Idem.
111	40.540	22.250	60.	140.	4	D	M	Idem.
112	40.500	23.400	160.		4	E	M	Idem.
113	38.780	24.550	162.		4	E	M	Idem.
114	36.550	24.260	122.		4	E	M	Idem.
115	36.260	25.320	130.		4	E	M	Idem.
116	35.000	25.750	130.		4	E	M	Idem.
117	36.260	28.100	125.		4	E	M	Idem.
118	36.730	27.100	38.		4	E	M	Idem.
119	39.000	26.550	5.		4	E	M	Idem.
120	40.500	25.830	95.	6.	4	D	M	Idem.
121	35.470	27.080	116.		4	E	M	Mercier,1987.
122	38.500	27.550	21.		4	E	M	Idem.
123	40.750	26.100	168.		4	E	M	Idem.
124	40.650	24.710	163.		4	E	M	Idem.
125	39.960	25.220	170.		4	E	M	Idem.
126	39.450	25.000	162.		4	E	M	Idem.
127	39.250	38.100	142.		4	E	M	Idem.
128	38.290	22.750	37.		4	E	M	Idem.
129	40.100	22.500	163.		4	E	M	Idem.
130	40.300	22.000	141.		4	E	M	Idem.
131	38.100	20.450	146.		4	E	M	Idem.
132	38.800	20.800	0.		4	E	M	Idem.
133	39.250	20.100	60.		4	C	M	Idem.
134	36.220	23.000	98.		4	E	M	Idem.
135	35.870	23.300	117.		4	E	M	Idem.
136	37.550	29.250	110.		3	E	M	Dupoux,1983.
137	37.120	30.220	86.		3	E	M	Idem.
138	34.750	32.500	21.		3	E	M	Idem.
139	38.800	35.980	22.		3	C	M	Idem.
140	37.400	38.200	0.		3	C	M	Idem.
141	42.000	45.800	33.		4	C	M	Philip & al.,1989.
142	41.970	42.400	171.		4	C	M	Idem.
143	41.620	42.750	142.		4	C	M	Idem.
144	41.640	42.970	132.		4	C	M	Idem.
145	41.700	43.300	150.		4	C	M	Idem.
146	41.770	43.100	75.		4	E	M	Idem.
147	41.930	43.500	170.		4	C	M	Idem.
148	36.620	29.500	90.		3	E	M	Dumont & al.,1979.
149	37.590	26.680	64.		3	E	M	Idem.
150	38.200	26.050	75.		3	E	M	Idem.
151	37.100	24.800	28.		4	E	M	Idem.
152	35.300	25.100	5.		4	E	M	Idem.
153	35.200	26.300	152.		3	E	M	Idem.
154	41.100	15.020	175.		3	E	M	Philip,1983.
155	40.750	14.450	132.		3	E	M	Idem.
156	40.900	15.540	67.		4	E	M	Idem.
157	40.480	15.300	125.		3	E	M	Idem.
158	40.600	14.950	170.		4	E	M	Idem.
159	40.510	14.850	122.		4	E	M	Idem.
160	40.180	16.480	121.		4	E	M	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
161	40.000	16.550	129.		3	E	M	Idem.
162	39.900	16.460	109.		3	E	M	Idem.
163	39.960	16.080	166.		3	E	M	Idem.
164	39.950	16.000	79.		4	E	M	Idem.
165	39.500	16.210	106.		4	E	M	Idem.
166	39.470	16.890	135.		4	E	M	Idem.
167	38.800	16.560	27.		4	E	M	Idem.
168	38.790	16.490	65.		4	E	M	Idem.
169	38.600	16.080	168.		3	E	M	Idem.
170	38.220	15.720	62.		4	E	M	Idem.
171	38.100	15.540	115.		4	E	M	Idem.
172	38.300	14.900	116.		4	E	M	Idem.
173	38.110	15.300	116.		3	E	M	Idem.
174	35.500	23.710	80.		3	E	M	Idem.
175	40.030	18.180	10.		3	C	M	Idem.
176	40.470	16.560	35.		3	C	M	Idem.
177	40.300	15.900	34.		4	E	M	Idem.
178	41.610	15.520	18.		4	C	M	Idem.
179	38.910	16.240	92.		4	E	M	Idem.
180	37.210	13.710	28.		3	C	M	Idem.
181	43.730	7.250	14.		3	C	M	Idem.
182	43.800	6.200	25.		3	C	M	Idem.
183	43.950	6.000	161.		3	C	M	Idem.
184	44.000	4.700	145.		3	C	M	Idem.
185	43.300	3.400	141.		3	C	M	Idem.
186	44.900	3.250	67.		3	E	M	Idem.
187	42.130	3.100	158.	68.	3	D	M	Idem.
188	41.450	2.120	168.		3	C	M	Idem.
189	40.900	0.700	88.		3	E	M	Idem.
190	49.260	2.200	170.		4	C	M	Idem.
191	38.300	-0.480	150.		4	C	M	Idem.
192	37.750	-1.460	143.		4	C	M	Idem.
193	37.600	-1.750	150.		3	C	M	Idem.
194	37.010	-2.050	143.		3	C	M	Idem.
195	36.730	-2.240	153.		3	C	M	Idem.
196	36.680	-2.850	147.		3	C	M	Idem.
197	36.770	-4.980	141.		3	C	M	Idem.
198	36.500	-6.200	143.		3	C	M	Idem.
199	35.500	-0.200	147.	57.	3	D	M	Idem.
200	43.000	11.200	123.		3	E	M	Idem.
201	35.650	15.090	179.		3	C	M	Idem.
202	42.400	9.450	98.		4	E	M	Philip, unpublished.
203	29.880	32.300	65.		3	E	M	Steckler & al., 1988.
204	29.800	32.480	95.		3	E	M	Idem.
205	29.880	32.980	150.	60.	3	D	M	Idem.
206	29.250	33.060	87.		3	E	M	Idem.
207	29.000	33.250	89.		3	E	M	Idem.
208	28.880	33.250	80.		3	E	M	Idem.
209	28.300	32.300	170.	80.	3	D	M	Idem.
210	28.180	32.800	92.		3	E	M	Idem.
211	27.750	34.350	98.		3	E	M	Idem.
212	27.850	34.400	80.		3	E	M	Idem.
213	28.130	34.400	84.		3	E	M	Idem.
214	28.250	34.400	90.		3	E	M	Idem.
215	28.500	34.600	110.		3	E	M	Idem.
216	28.600	34.600	90.		3	E	M	Idem.
217	28.700	34.450	87.		3	E	M	Idem.
218	28.750	34.600	88.		3	E	M	Idem.
219	29.000	34.750	85.		3	E	M	Idem.
220	29.100	34.780	108.		3	E	M	Idem.
221	29.300	34.800	98.		3	E	M	Idem.
222	29.350	34.850	82.		3	E	M	Idem.
223	29.400	34.840	75.		3	E	M	Idem.
224	30.600	31.620	0.		3	C	M	Idem.
225	31.370	39.300	178.	88.	3	D	M	Giannerini, 1988.
226	32.620	38.050	0.	90.	3	D	M	Idem.
227	33.750	37.000	0.	90.	3	D	M	Idem.
228	35.970	36.300	82.		3	E	M	Idem.
229	37.550	38.020	176.		3	C	M	Idem.
230	38.000	41.800	15.		3	C	M	Idem.
231	36.500	43.500	45.		3	C	M	Idem.
232	30.500	49.500	45.		3	C	M	Idem.
233	40.000	25.400	10.		3	E	M	Lybéris & Sauvage, 1985.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
234	40.400	25.500	0.		3	E	M	Idem.
235	41.000	25.400	170.		3	E	M	Idem.
236	41.000	25.400	13.		3	E	M	Idem.
237	40.980	24.970	24.		3	E	M	Idem.
238	40.950	24.720	0.		3	E	M	Idem.
239	40.820	24.400	173.		3	E	M	Idem.
240	40.800	24.370	10.		3	E	M	Idem.
240	40.640	24.210	175.		3	E	M	Idem.
241	40.500	24.530	6.		3	E	M	Idem.
242	41.080	23.500	0.		3	E	M	Idem.
243	31.200	53.000	30.		4	C	M	Pourkermani,1977.
248	41.500	-6.850	170.		4.0	C	M	Cabral,1985.
249	37.300	-3.300	152.		4	C	M	Bousquet & al ,1978.
250	36.900	-3.620	140.	50.	4	D	M	Idem.
251	32.000	-6.250	148.		4	C	M	Pilip,unpubleshed.
252	32.150	-5.800	144.		4	C	M	Idem.
253	32.280	-5.560	154.		4	C	M	Idem.
254	32.250	-5.080	127.		4	C	M	Idem.
255	33.000	-5.500	0.		4	C	M	Idem.
256	36.250	-6.050	164.		3	C	M	Boccaletti & al.,1987.
257	36.620	-5.850	127.		3	C	M	Idem.
258	36.750	-5.750	128.		3	C	M	Idem.
259	36.500	-5.000	162.		3	C	M	Idem.
260	36.690	-4.050	20.		3	C	M	Idem.
261	37.130	-4.130	170.		3	C	M	Idem.
262	37.270	-3.630	157.		3	C	M	Idem.
263	36.630	-3.500	155.		3	C	M	Idem.
264	36.730	-3.400	172.		3	C	M	Idem.
265	36.920	-3.000	150.		3	C	M	Idem.
266	37.000	-2.520	167.		3	C	M	Idem.
267	37.300	-3.170	3.		3	C	M	Idem.
268	37.500	-2.980	173.		3	C	M	Idem.
269	37.050	-2.240	15.		3	C	M	Idem.
270	36.850	-1.960	172.		3	C	M	Idem.
271	37.380	-1.780	168.		3	C	M	Idem.
272	44.250	11.600	31.		3	C	M	Angiola,1987.
273	44.080	10.220	32.		3	E	M	Bernini,1988.
274	44.750	10.120	5.	95.	3	D	M	Bernini & Clerici,1983.
275	44.050	12.250	21.		3	C	M	Angiola,1987.
276	40.940	44.290	177.		3	C	M	Philip & al.,1991.
1	44.700	3.000	90.		2	E	V	Philip,1983.
2	43.900	2.780	86.		2	E	V	Idem.
3	43.620	3.250	93.		1	E	V	Idem.
4	43.400	3.500	84.		2	E	V	Idem.
5	42.080	2.630	54.		2	E	V	Idem.
6	38.830	-3.920	60.		1	E	V	Idem.
7	40.560	8.750	64.		1	E	V	Idem.
8	40.180	8.750	107.		2	E	V	Idem.
9	39.750	8.760	88.		1	E	V	Idem.
10	27.060	42.400	100.		1	E	V	Giannerini,1988.
11	26.830	42.280	101.		2	E	V	Idem.
12	27.000	42.200	101.		2	E	V	Idem.
13	26.750	40.310	67.		2	E	V	Idem.
14	26.750	40.000	67.		2	E	V	Idem.
15	26.400	40.130	67.		2	E	V	Idem.
16	26.200	40.250	67.		1	E	V	Idem.
17	26.300	40.020	67.		1	E	V	Idem.
18	26.320	39.790	67.		1	E	V	Idem.
19	27.130	37.550	58.		2	E	V	Idem.
20	27.130	37.450	58.		3	E	V	Idem.
21	27.350	37.530	86.		1	E	V	Idem.
22	27.350	37.500	100.		1	E	V	Idem.
23	27.380	37.380	96.		3	E	V	Idem.
24	27.370	37.280	94.		1	E	V	Idem.
25	27.380	37.250	94.		2	E	V	Idem.
26	27.390	37.220	94.		1	E	V	Idem.
27	27.500	37.050	55.		1	E	V	Idem.
28	27.390	36.950	57.		2	E	V	Idem.
29	27.650	36.750	57.		1	E	V	Idem.
30	27.570	36.720	57.		2	E	V	Idem.
31	31.250	34.850	70.		2	E	V	Idem.
32	30.520	39.070	93.		2	E	V	Idem.
33	30.750	39.000	90.		2	E	V	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
34	30.820	39.070	87.		2	E	V	Idem.
35	30.870	38.590	80.		1	E	V	Idem.
36	31.070	38.740	85.		1	E	V	Idem.
37	31.320	38.980	80.		2	E	V	Idem.
38	31.750	38.980	85.		3	E	V	Idem.
39	31.380	38.720	90.		1	E	V	Idem.
40	31.520	38.680	90.		1	E	V	Idem.
41	31.100	38.600	86.		1	E	V	Idem.
42	31.130	38.500	90.		1	E	V	Idem.
43	31.500	38.150	90.		1	E	V	Idem.
44	31.310	38.150	85.		2	E	V	Idem.
45	31.200	37.750	86.		1	E	V	Idem.
46	31.100	37.750	52.		2	E	V	Idem.
47	32.020	37.660	54.		2	E	V	Idem.
48	32.020	37.650	67.		1	E	V	Idem.
49	32.190	37.660	75.		1	E	V	Idem.
50	32.250	37.600	75.		1	E	V	Idem.
51	32.320	37.610	58.		1	E	V	Idem.
52	32.500	37.600	57.		1	E	V	Idem.
53	32.500	37.500	71.		1	E	V	Idem.
54	32.720	37.750	72.		1	E	V	Idem.
55	32.700	37.350	70.		1	E	V	Idem.
56	32.900	37.480	60.		1	E	V	Idem.
57	32.810	37.220	68.		2	E	V	Idem.
58	33.060	37.250	73.		1	E	V	Idem.
59	33.250	37.240	98.		1	E	V	Idem.
60	33.200	37.200	63.		1	E	V	Idem.
61	33.250	37.000	70.		1	E	V	Idem.
62	33.350	37.110	63.		1	E	V	Idem.
63	33.450	37.150	60.		2	E	V	Idem.
64	33.480	37.270	63.		2	E	V	Idem.
65	33.500	37.000	75.		1	E	V	Idem.
66	33.550	37.030	70.		2	E	V	Idem.
67	33.570	37.100	70.		1	E	V	Idem.
68	33.700	373.570	49.		2	E	V	Idem.
69	33.900	37.800	69.		1	E	V	Idem.
70	33.900	38.630	43.		2	E	V	Idem.
71	33.950	38.750	66.		2	E	V	Idem.
72	32.070	37.100	68.		1	E	V	Idem.
73	32.200	37.020	68.		2	E	V	Idem.
74	32.130	37.000	74.		1	E	V	Idem.
75	32.170	36.820	70.		1	E	V	Idem.
76	32.300	36.730	63.		2	E	V	Idem.
77	32.380	36.760	84.		1	E	V	Idem.
78	32.380	36.750	66.		2	E	V	Idem.
79	32.590	36.850	77.		2	E	V	Idem.
80	32.590	36.730	84.		2	E	V	Idem.
81	32.700	36.600	84.		2	E	V	Idem.
82	32.760	36.790	79.		2	E	V	Idem.
83	32.760	36.790	67.		2	E	V	Idem.
84	32.880	36.880	72.		2	E	V	Idem.
85	33.000	36.880	25.		1	E	V	Idem.
86	33.150	36.750	69.		1	E	V	Idem.
87	32.980	36.600	64.		2	E	V	Idem.
88	33.130	36.630	80.		1	E	V	Idem.
89	34.820	36.380	74.		1	E	V	Idem.
90	33.150	35.750	67.		1	E	V	Idem.
91	32.880	36.120	65.		2	E	V	Idem.
92	33.000	35.820	67.		1	E	V	Idem.
93	33.260	35.800	66.		1	E	V	Idem.
94	33.140	36.000	70.		1	E	V	Idem.
95	33.140	36.190	66.		2	E	V	Idem.
96	33.150	36.100	67.		2	E	V	Idem.
97	35.450	39.480	80.		1	E	V	Idem.
98	35.880	39.300	96.		1	E	V	Idem.
99	35.860	39.380	70.		1	E	V	Idem.
100	35.630	39.770	100.		1	E	V	Idem.
101	35.500	40.250	101.		1	E	V	Idem.
102	35.700	40.900	85.		1	E	V	Idem.
103	35.760	40.680	40.		1	E	V	Idem.
104	36.500	40.900	98.		1	E	V	Idem.
105	36.650	40.530	76.		2	E	V	Idem.
106	36.920	40.130	68.		2	E	V	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
107	37.880	40.000	72.		2	E	V	Idem.
108	37.770	39.500	78.		2	E	V	Idem.
109	35.620	38.880	77.		1	E	V	Idem.
110	37.130	42.000	80.		2	E	V	Idem.
111	39.050	43.050	63.		2	E	V	Philip & al.,1989.
112	40.880	43.000	83.		2	E	V	Idem.
113	39.890	43.000	78.		2	E	V	Idem.
114	43.180	42.880	112.		2	E	V	Idem.
115	38.700	47.980	120.		2	E	V	Idem.
116	35.550	36.600	88.		1	E	V	Idem.
117	35.600	36.420	95.		1	E	V	Idem.
118	35.800	36.380	80.		2	E	V	Idem.
119	35.820	36.500	80.		1	E	V	Idem.
1	43.620	-0.500	109.		3	C	I	Janot & al.,1987.
2	55.600	4.700	164.		3	C	I	Idem.
3	58.750	1.900	145.		3	C	I	Idem.
4	59.750	2.500	115.		3	C	I	Idem.
5	59.900	2.250	165.		3	C	I	Idem.
6	59.980	2.750	118.		3	C	I	Idem.
7	60.320	3.000	128.		3	C	I	Idem.
8	60.520	2.990	108.		3	C	I	Idem.
9	60.900	3.750	155.		3	C	I	Idem.
10	60.500	2.000	165.		3	C	I	Idem.
11	60.720	1.980	165.		3	C	I	Idem.
12	60.950	2.180	97.		3	C	I	Idem.
13	61.750	2.000	146.		3	C	I	Idem.
14	43.700	0.180	122.		3	C	I	Idem.
15	48.080	2.080	142.		3	C	I	Idem.
16	48.400	2.000	118.		3	C	I	Idem.
17	48.600	2.600	150.		3	C	I	Idem.
18	48.250	3.180	152.		3	C	I	Idem.
19	48.720	3.650	140.		3	C	I	Idem.
20	49.120	3.500	54.		3	C	I	Idem.
21	49.000	3.980	168.		3	C	I	Idem.
22	43.420	14.000	126.		3	C	I	Idem.
23	39.800	16.500	122.		3	C	I	Idem.
24	45.800	12.350	145.		3	C	I	Idem.
25	45.970	4.800	142.		3	C	I	Idem.
26	47.400	9.000	173.		3	C	I	Idem.
27	47.500	8.250	162.		3	C	I	Idem.
28	47.900	8.500	159.		3	C	I	Idem.
29	48.800	9.000	170.		3	C	I	Idem.
30	52.350	7.300	146.		3	C	I	Draxler & Edwards,1984.
31	52.400	6.700	136.		3	C	I	Idem.
32	52.660	6.510	121.		3	C	I	Idem.
33	52.750	6.660	131.		3	C	I	Idem.
34	52.730	8.530	145.		3	C	I	Idem.
35	52.680	8.630	146.		3	C	I	Idem.
36	52.780	9.150	147.		3	C	I	Idem.
37	52.730	9.550	148.		3	C	I	Idem.
38	53.100	9.700	141.		3	C	I	Idem.
39	53.160	9.830	132.		3	C	I	Idem.
40	53.260	8.950	156.		3	C	I	Idem.
41	58.360	4.580	114.		3	C	I	Cox,1983.
42	54.200	4.750	139.		3	C	I	Janot & al.,1987.
43	56.800	2.500	124.		3	C	I	Idem.
44	57.650	1.180	160.		3	C	I	Idem.
45	61.250	1.750	129.		3	C	I	Idem.
46	60.100	-4.250	143.		3	C	I	Idem.
47	59.800	-4.250	8.		3	C	I	Idem.
48	56.620	-1.100	170.		3	C	I	Idem.
49	53.500	-2.000	156.		3	C	I	Idem.
50	54.120	1.000	154.		3	C	I	Idem.
51	54.000	0.900	130.		3	C	I	Idem.
52	53.000	1.500	97.		3	C	I	Idem.
53	53.300	-0.200	140.		3	C	I	Idem.
54	53.400	-0.750	143.		3	C	I	Idem.
55	53.500	-0.500	100.		3	C	I	Idem.
56	53.200	-0.050	140.		3	C	I	Idem.
57	53.000	-0.500	144.		3	C	I	Idem.
58	50.200	8.500	162.		3	C	I	Idem.
59	46.000	3.250	135.		4	C	I	Cornet,1984.
60	46.030	3.660	16.		4	C	I	Cornet & Valette,1984.

Table 1. *(continued)*

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
61	48.010	5.160	148.		1	C	I	Froidevaux & al.,1980.
62	47.880	4.510	149.		1	C	I	Idem.
63	47.860	4.210	152.		1	C	I	Idem.
64	47.630	3.960	167.		1	C	I	Idem.
65	46.530	0.550	100.		1	C	I	Idem.
66	46.630	0.360	141.		1	C	I	Idem.
67	45.680	0.400	139.		1	C	I	Idem.
68	50.810	1.760	176.		1	C	I	Idem.
70	50.760	6.300	146.		3	C	I	Baumann,1981.
71	50.530	6.580	4.		3	C	I	Idem.
72	50.230	6.680	129.		3	C	I	Idem.
73	49.510	6.380	126.		3	C	I	Illis & Greiner,1977.
74	49.950	7.760	150.		3	C	I	Baumann,1981.
75	50.310	8.060	150.		3	C	I	Idem.
76	50.360	7.900	160.		4	C	I	Idem.
77	50.430	8.210	150.		4	C	I	Idem.
78	50.400	8.180	145.		3	C	I	Idem.
79	50.550	8.630	136.		3	C	I	Idem.
80	49.860	8.350	126.		3	C	I	Illis & Greiner,1977.
81	49.710	8.650	125.		3	C	I	Idem.
82	49.210	8.016	75.		3	C	I	Idem.
83	49.016	8.610	140.		3	C	I	Idem.
84	48.700	8.250	138.		3	C	I	Baumann,1981.
85	48.450	8.480	170.		3	C	I	Idem.
86	48.280	9.010	130.		3	C	I	Illis & Greiner,1977.
87	48.160	9.080	152.		3	C	I	Idem.
88	48.150	7.750	78.		3	C	I	Baumann,1981.
89	47.910	7.780	153.		3	C	I	Illis & Greiner,1977.
90	47.680	7.530	176.		3	C	I	Idem.
91	47.060	8.280	104.		3	C	I	Idem.
92	46.560	8.310	171.		3	C	I	Idem.
93	46.280	8.350	30.		3	C	I	Baumann,1981.
94	46.060	8.730	150.		3	C	I	Idem.
95	45.880	6.900	40.		3	C	I	Illis & Greiner,1977.
96	46.050	9.830	175.		3	C	I	Baumann,1981.
97	46.180	9.810	147.		3	C	I	Idem.
98	47.430	13.100	160.		3	C	I	Illis & Greiner,1977.
99	46.100	8.780	140.		3	C	I	Idem.
100	46.080	10.310	165.		3	C	I	Idem.
101	50.580	6.260	120.		3	C	I	Rummel & al.,1983.
103	52.070	9.880	140.		3	C	I	Idem.
104	52.080	8.880	108.		3	C	I	Idem.
105	51.950	8.650	108.		2	C	I	Idem.
106	51.850	10.260	112.		3	C	I	Idem.
107	50.930	9.850	151.		3	C	I	Idem.
108	50.650	9.500	160.		2	C	I	Idem.
109	50.200	9.510	156.		2	C	I	Idem.
110	50.030	9.680	153.		3	C	I	Idem.
111	49.860	12.240	115.		3	C	I	Idem.
112	49.830	12.280	115.		2	C	I	Idem.
113	51.850	7.860	1.		2	C	I	Draxler & Edwards,1984.
115	52.750	8.500	146.		3	C	I	Ranalli,1975.
116	50.180	-5.230	129.		3	C	I	Pine & al.,1983.
117	50.160	-5.160	132.		3	C	I	Batchelor & al.,1983.
118	66.350	14.110	88.		2	C	I	Broch & Nilsen,1978.
120	59.760	15.000	120.		3	C	I	Stephansson & al.,1987.
121	60.600	16.250	10.		3	C	I	Idem.
122	67.210	20.680	100.		3	C	I	Ranelli,1975.
122	67.210	20.680	3.		3	C	I	Stephansson & al.,1987.
123	69.730	30.000	23.		3	C	I	Ranelli,1975.
124	67.930	20.330	163.		3	C	I	Idem.
125	64.200	11.110	162.		3	C	I	Idem.
125	64.200	11.110	2.		3	C	I	Stephansson & al.,1987.
126	62.150	5.330	91.		3	C	I	Ranelli,1975.
127	59.900	5.300	86.		2	C	I	Idem.
128	58.160	6.750	114.		2	C	I	Idem.
129	67.550	33.710	120.		2	C	I	Idem.
130	66.200	16.830	163.		2	C	I	Idem.
130	66.200	16.830	2.		3	C	I	Stephansson & al.,1987.
131	69.130	23.060	0.		3	C	I	Idem.
132	63.000	9.000	40.		3	C	I	Idem.
132	63.000	9.000	108.		3	C	I	Ranelli,1975.
133	62.930	56.800	2.		3	C	I	Stephansson & al.,1987.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
134	67.150	16.000	3.		3	C	I	Idem.
135	66.500	14.660	28.		3	C	I	Idem.
136	66.000	14.000	177.		2	C	I	Idem.
137	62.180	9.600	0.		2	C	I	Idem.
138	62.000	7.760	142.		2	C	I	Idem.
139	60.000	10.050	0.		3	C	I	Idem.
140	59.010	9.080	0.		2	C	I	Idem.
141	60.010	23.500	151.		3	C	I	Idem.
142	41.550	8.380	98.		3	C	I	Hast,1969.
143	69.000	30.000	4.		3	C	I	Stephansson & al.,1987.
144	60.430	1.750	157.		3	C	I	Cox.,1983.
146	58.370	4.580	149.		3	C	I	Idem.
148	40.750	22.830	110.	200.	3	D	I	Paquin & al.,1982.
149	41.000	22.750	95.	185.	3	D	I	Idem.
150	31.930	12.850	52.		3	E	I	Shäfer,1980.
151	31.880	13.120	105.		3	C	I	Idem.
152	31.350	13.140	141.		3	C	I	Idem.
153	31.560	13.120	42.		3	C	I	Idem.
154	32.020	12.620	139.		2	C	I	Idem.
155	32.300	13.050	107.		2	C	I	Idem.
156	32.480	13.000	169.		2	C	I	Idem.
157	32.460	12.840	102.		2	C	I	Idem.
158	32.470	13.080	103.		2	C	I	Idem.
159	32.650	14.230	45.		3	C	I	Idem.
160	32.800	21.900	148.		2	C	I	Idem.
161	32.520	21.650	35.		2	C	I	Idem.
162	32.480	21.750	26.		3	C	I	Idem.
163	32.730	22.690	104.		2	C	I	Idem.
164	32.720	22.270	29.		2	C	I	Idem.
165	32.770	22.240	94.		2	C	I	Idem.
166	32.770	21.630	173.		2	C	I	Idem.
167	32.500	21.000	50.		2	C	I	Idem.
168	32.480	20.500	54.	144.	2	D	I	Idem.
169	31.900	11.800	123.		2	C	I	Idem.
170	30.100	10.600	144.		2	C	I	Idem.
171	30.750	10.610	131.		2	C	I	Idem.
172	28.900	15.700	118.		2	C	I	Idem.
173	29.100	15.900	110.		2	C	I	Idem.
174	29.350	16.480	149.	59.	2	D	I	Idem.
175	29.250	16.450	170.	80.	3	D	I	Idem.
177	38.000	15.200	175.		3	C	I	Bousquet & al.,1987.
178	37.970	15.100	8.		3	C	I	Idem.
179	37.900	14.900	5.		3	C	I	Idem.
180	37.750	14.800	112.		3	E	I	Idem.
181	37.650	14.900	108.		3	E	I	Idem.
182	37.250	14.900	120.		3	E	I	Idem.
183	37.100	14.750	110.		3	E	I	Idem.
184	40.750	21.830	170.		3	E	I	Paquin & al.,1982.
185	39.330	22.410	110.	200.	3	D	I	Idem.
186	38.170	24.000	135.		3	E	I	Idem.
187	40.830	25.750	255.		3	E	I	Idem.
188	40.850	25.500	165.		3	E	I	Idem.
189	41.000	24.750	215.		3	E	I	Idem.
190	40.910	24.420	90.		3	E	I	Idem.
191	40.250	21.420	95.		3	E	I	Idem.
192	39.750	20.670	110.		3	E	I	Idem.
193	39.670	20.750	110.		3	E	I	Idem.
194	39.670	20.750	160.		3	E	I	Idem.
195	37.580	22.330	190.		3	E	I	Idem.
196	37.380	22.330	100.	190.	3	D	I	Idem.
197	36.750	22.830	95.	185.	3	D	I	Idem.
198	48.460	-1.150	107.		3	C	I	Paquin & al.,1978.
199	50.500	14.700	167.		2	C	I	Ahorner,1975.
200	50.450	15.000	166.		2	C	I	Idem.
203	51.000	15.750	52.		3	E	I	Stephansson & al,1987.
204	50.900	15.250	170.		3	C	I	Idem.
205	50.700	15.000	128.		3	C	I	Idem.
206	50.750	14.000	138.		3	C	I	Idem.
207	50.700	15.780	156.		3	C	I	Idem.
208	49.750	14.180	99.		3	C	I	Idem.
209	47.620	16.760	10.		3	C	I	Idem.
210	47.750	17.100	160.		3	C	I	Idem.
211	47.300	12.500	115.		3	C	I	Idem.

Table 1. (*continued*)

NU	Lat	Long	Az1	Az3	Q	CT	TD	References
212	46.700	13.750	165.		3	C	I	Idem.
213	46.700	13.750	124.		3	C	I	Idem.
214	46.100	10.100	144.		3	C	I	Idem.
215	47.500	4.550	142.		3	C	I	Idem.
216	47.720	5.180	140.		3	C	I	Idem.
217	49.800	7.750	65.		3	C	I	Idem.
218	50.180	9.300	150.		3	C	I	Idem.
219	50.700	9.950	147.		3	C	I	Idem.
220	51.820	8.600	144.		3	C	I	Idem.
221	51.250	8.480	30.		3	C	I	Idem.
222	51.300	8.400	60.		3	C	I	Idem.
223	51.750	10.250	0.		3	E	I	Idem.
224	50.480	6.700	95.		3	E	I	Idem.
225	50.600	6.500	53.		3	C	I	Idem.
226	51.600	11.000	173.		3	C	I	Idem.
227	51.270	7.000	155.		3	C	I	Idem.
228	49.850	6.750	120.		3	C	I	Idem.
229	36.480	1.800	17.		3	C	I	Beghoul,1984.
230	36.500	2.000	8.	0.	3	D	I	Idem.
231	36.520	2.100	130.		3	C	I	Idem.
232	64.130	-22.000	164.		3	C	I	Schäfer & Keil,1979.
233	64.430	-21.000	168.		3	C	I	Idem.
234	65.700	-17.800	120.		3	C	I	Idem.
235	65.000	-14.500	55.		3	C	I	Idem.
236	65.450	-20.200	162.		3	C	I	Idem.
237	64.080	-16.600	133.		3	C	I	Idem.
238	64.250	-15.800	110.		3	C	I	Idem.
239	64.350	-15.100	115.		3	C	I	Idem.
240	64.800	-14.600	28.		3	C	I	Idem.
241	65.430	-14.300	130.		3	C	I	Idem.
242	65.430	-14.800	147.		3	C	I	Idem.
243	65.500	-15.600	128.		3	C	I	Idem.
244	65.980	-16.400	92.		3	C	I	Idem.
245	65.000	-16.900	114.		3	C	I	Idem.
246	66.280	-17.000	91.		3	C	I	Idem.
247	64.150	-21.200	32.		3	C	I	Idem.
248	64.250	-21.000	42.		3	C	I	Idem.
249	64.450	-23.200	108.		3	C	I	Idem.
250	64.100	-22.700	83.		3	C	I	Idem.
251	64.500	-14.600	108.		3	C	I	Idem.
252	65.680	-18.200	178.		3	C	I	Idem.
253	64.450	-15.000	115.		3	C	I	Idem.
254	65.250	-14.000	166.		3	C	I	Idem.
255	41.550	-8.500	98.		3	C	I	Hast,1969.
256	42.500	1.980	0.		1	C	I	calculated from E.D.F. data.
257	45.180	2.250	140.		1	C	I	Idem.
258	45.170	6.250	8.		1	C	I	Idem.
259	45.600	6.000	107.		1	C	I	Idem.
260	49.980	4.700	32.		1	C	I	Idem.
261	42.700	1.500	175.		1	C	I	Idem.
262	47.250	1.500	65.		3	C	I	calculated from G.D.F. data.
262	47.250	1.500	140.		3	C	I	Idem.
263	44.000	-0.700	17.		3	C	I	Idem.
264	49.200	1.720	45.		3	C	I	Idem.
265	49.180	1.820	117.		3	C	I	Idem.
266	48.700	6.300	165.		3	C	I	Idem.
267	49.500	2.800	175.		3	C	I	Idem.
268	49.700	0.750	20.		3	C	I	Idem.
269	47.240	1.620	130.		3	C	I	Idem.
270	47.500	1.550	38.		3	C	I	Idem.
271	45.400	0.000	110.		3	C	I	Idem.
272	47.200	1.250	150.		3	C	I	Idem.
273	47.250	8.180	130.		3	C	I	Idem.
274	34.750	10.780	150.		2	C	I	Boccaletti & al.,1988.
275	39.760	19.930	70.	160.	3	D	I	Paquin & al.,1984.
276	38.460	20.580	90.	190.	3	D	I	Idem.
277	37.530	25.210	106.		4	E	I	Idem.
278	37.080	25.200	113.		3	E	I	Idem.
279	36.950	24.750	168.		3	E	I	Idem.
280	36.750	24.510	165.		2	E	I	Idem.
281	36.680	24.460	162.		3	E	I	Idem.
282	35.400	24.700	113.		2	E	I	Idem.
283	35.330	25.250	157.		4	E	I	Idem.

any triangular element should have comparable lengths (i.e. the ideal element is the equilateral triangle).

The average direction on each node of the grid is calculated from stress data localized inside a circle defined around the node. The radius R of each circle is defined proportional to the size of the smallest triangle connected to the node. The average is weighted by the product of a scale factor s and the quality factor q associated with each stress datum. The scale factor s is proportional to the stress measurement scale and consequently depends on the type of stress indicator. *In situ* stress measurements, microtectonic data and focal mechanisms supply information on the average stress direction at metre scale, centimetre to decametre scale and kilometre scales, respectively. In the case of focal mechanisms, the length of the fault rupture is taken as an indicator of the scale. Rupture lengths can be estimated from earthquake magnitudes and type of faulting (Bonilla *et al.* 1984).

The interpolated average directions have been calculated on the nodes of a square element mesh that is superimposed onto the triangular element grid. The *reliability* of the interpolated direction in each node of this mesh is assumed to be related to (a) the weight of the average directions in the nodes of the triangular element and (b) the distance to these nodes. On the maps, the reliability is depicted as proportional to the *length* of the line segment indicating the average interpolated direction.

This method is suitable when the S_{hmax} (or S_{hmin}) directions are well defined. Thus, when the stress tensor ellipsoid corresponds to an ellipsoid of revolution around the vertical axis, interpolation is not possible. In the case where strong discontinuities of stress directions are present (i.e. subduction zones and large-scale faults), triangular elements do not intersect them.

6 STRESS MAP OF THE MEDITERRANEAN AND SURROUNDING AREA

The modern stress field in the Mediterranean and surrounding area has been calculated from the interpolation of stress data as previously explained and results are illustrated on Fig. 10. Different symbols for stress directions have been used according to the stress regime specified in Fig. 8. In the western Mediterranean to the west of the longitude of Corsica and Sardinia, the maximum horizontal stress is directed N–S to NNW–SSE, roughly parallel to the relative displacement vector between the European and African plates, except on arc structures such as the western Alps and Gibraltar arc where small stress deviations are observed at plate scale (Fig. 10). This relative simplicity contrasts with the central and the eastern Mediterranean, where the stress field presents numerous deviations. These directional changes are localized within collision zones associated with large-scale faults and mountain belts as well as within active subduction zones (Tyrrhenean and Aegean subductions).

6.1 Some examples of stress deviations

6.1.1 The young continental collision between the Arabian plate and the Russian platform

The average stress field over this large intracontinental region indicates numerous directional changes of the maximum horizontal stress (S_{hmax}). These deviations are present along major tectonic structures at lithospheric scale (Fig. 11).

Within the central part of this region, which extends between the northern front of the Arabian wedge and the Russian platform, the orientation of S_{hmax} is generally north–south subparallel to the relative convergent motion between the Arabian plate and Russian platform (Philip *et al.* 1989). The accordance between stress direction and plate motion is no longer valid within the eastern and western parts of this large zone (Iranian and Anatolian regions). Within the Anatolian area, the S_{hmax} direction is roughly perpendicular to the relative N–S convergence between the Arabian plate and the Russian platform. In fact, the stress direction undergoes a progressive counterclockwise rotation from a NW–SE trend in eastern Anatolia to NE–SW trend in western Anatolia. In the same way, the state of stress changes from compressional in the east to extensional in the west. In particular, radial extension is localized within the southern part of the Aegean basin. These stress trajectories are coherent with the kinematics of large-scale active strike–slip faults which limit the Anatolian block, as well as with the smaller active faults localized within this block. The stress pattern is thus consistent with the westward movement of the Anatolian block pushed away from the collision zone along the north Anatolian right lateral strike–slip fault (NAF) to the north, and the east Anatolian left lateral fault (EAF) to the east (McKenzie 1972; Dewey & Sengör, 1979). While most of the relative lateral movement of the Anatolian block is absorbed by the Aegean subduction, some is also absorbed by intracontinental deformation. Consequently, both the westward motion of the Anatolian block and convergence between the Eurasian and African plates are absorbed along the Aegean subduction zone. Extensional tectonics along the Aegean back-arc basin may suggest that the coupling between the African plate and the Anatolian block is weak. In this particular case, the Aegean subduction zone can be considered as a free edge zone.

Stress deviations are also present in the eastern part of the continental collision between the Arabian plate and the Russian platform. S_{hmax} undergoes a clockwise rotation from the central part of the collision zone to the western part of the Caspian Sea, passing from a N–S direction to a NE–SW direction. This stress pattern is symmetric with the one described previously on the western side of the collision zone. On the southern coast of the Caspian Sea (Alborz mountains) S_{hmax} is once again oriented N–S. In the east (Kopeh Dagh mountains), the stress undergoes a new counterclockwise rotation and is oriented roughly NW–SE. This stress rotation may be linked to the convergence between the Lut microblock and the Eurasian plate.

The general stress pattern around the Caspian Sea is subperpendicular to the recent fold axis and is also consistent with the kinematics of major active strike–slip and thrust faults that surround the relatively undeformed south Caspian depression. The general arcuate shape of these bordering structures and mountain belts follows the boundary of the south Caspian oceanic crust (Berberian 1983). Hence, continental lithosphere is pressed closely against this old, hard core. In addition, some focal mechanisms on the southern border of the Caspian Sea (Jackson & McKenzie 1984) can be interpreted as

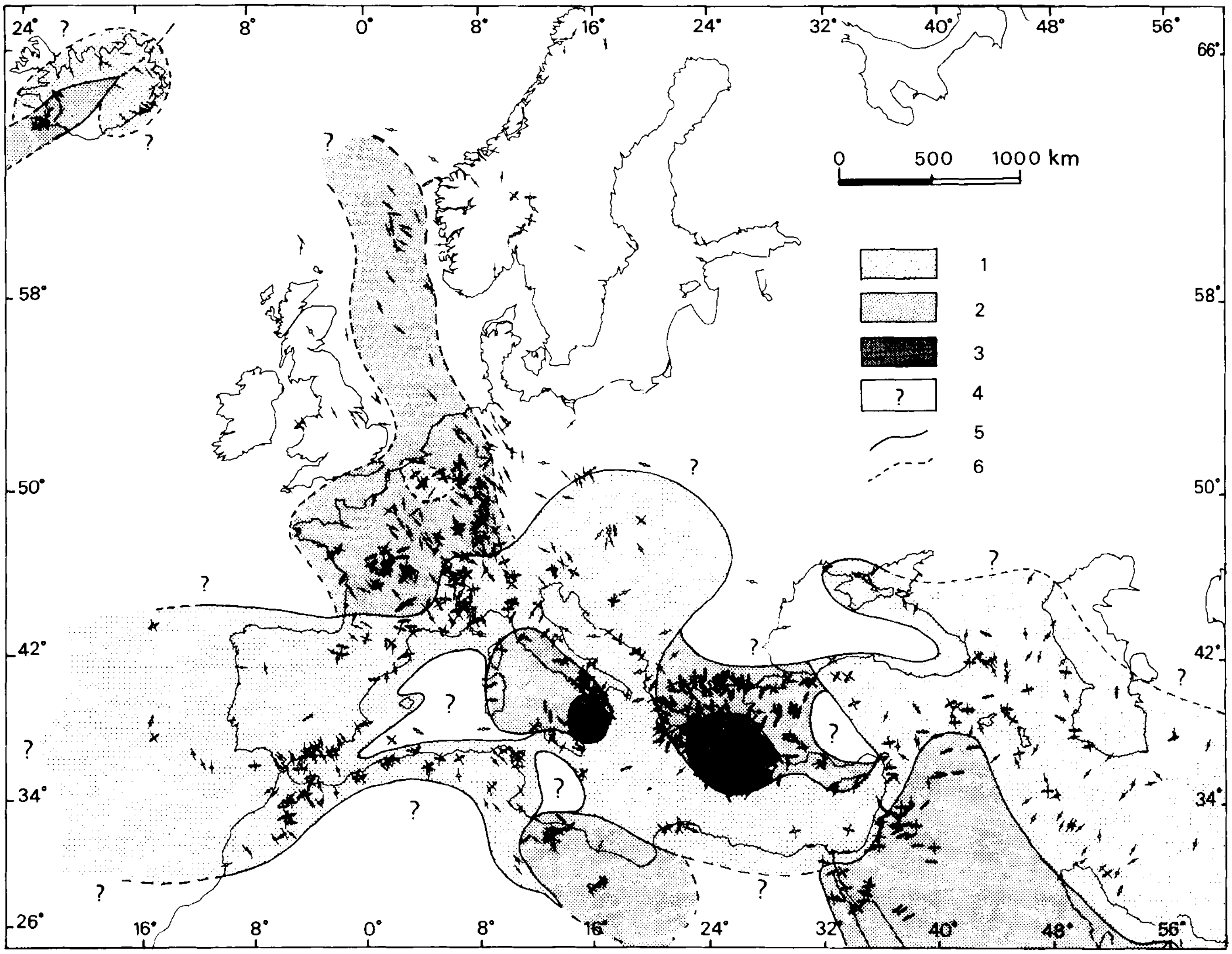

Figure 8. Map indicating the localization of the different types of zone defined in the Mediterranean and surrounding area, according to the tectonic regime. All the compiled stress data are shown. 1—Zone displaying reverse and strike-slip faulting; 2—zone displaying normal and strike-slip faulting; 3—tectonic regime close to radial extension; 4—undetermined tectonic regime; 5—well constrained limit of zone; 6—not well determined limit of zone.

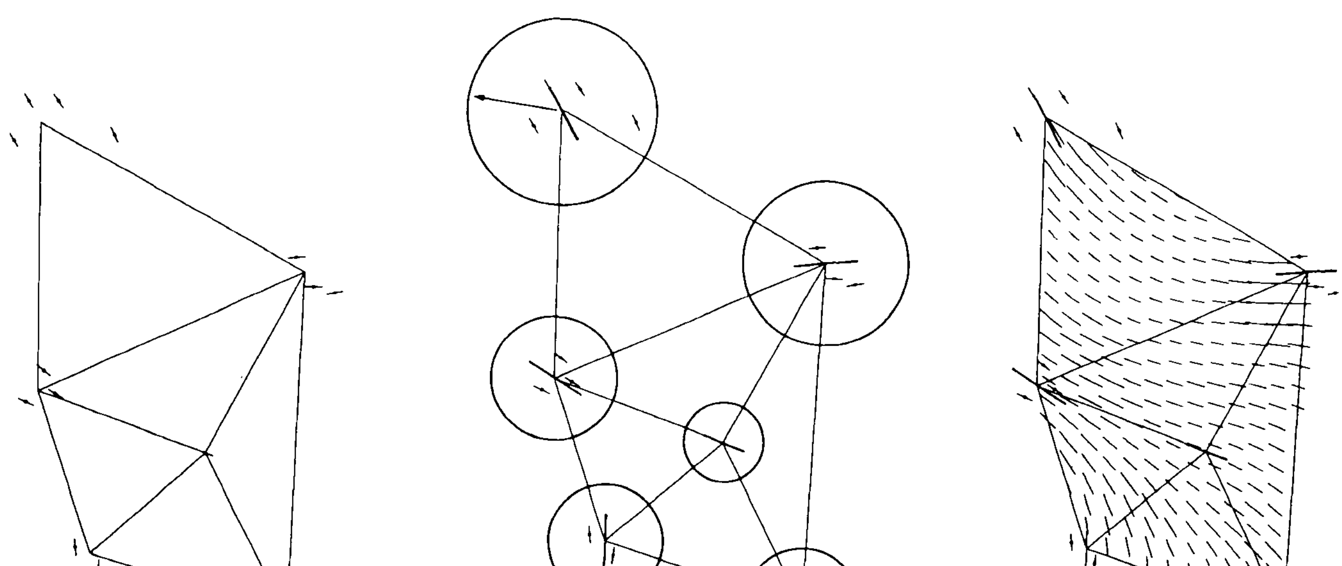

Figure 9. Example illustrating the methodology for determination of the mean stress directions. (a) Construction of triangular element grid from stress data map. (b) Calculation of mean directions on grid nodes from data inside circles. (c) Linear interpolation inside triangular elements from mean directions in the nodes.

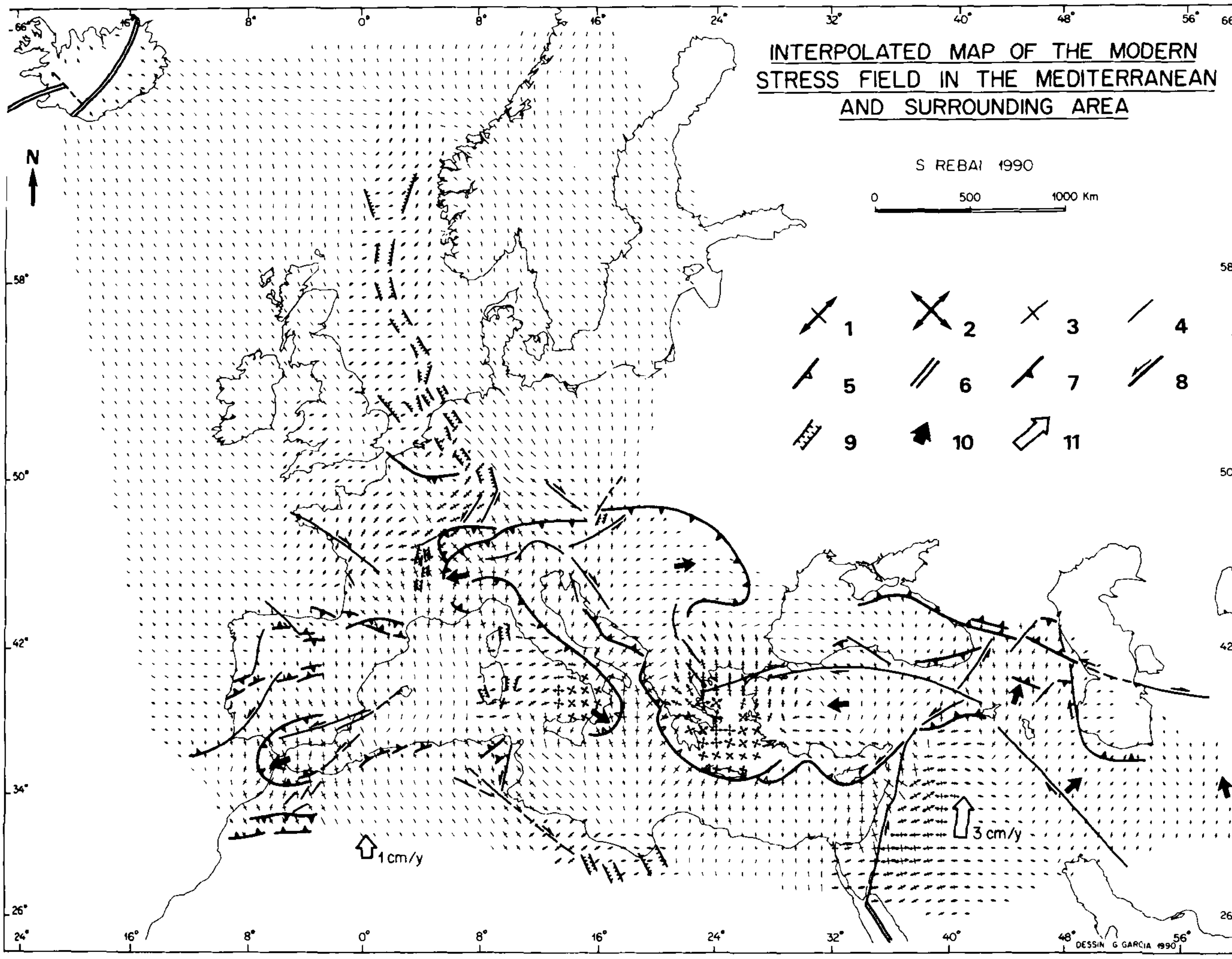

Figure 10. Interpolated map of the modern stress field in the Mediterranean and surrounding area. 1—Strike-slip extension tectonic context; 2—radial extension; 3—strike-slip compression; 4—non-defined context; 5—subduction trenches; 6—oceanic ridge; 7—reverse fault and thrust; 8—strike-slip fault; 9—graben; 10—block movements with respect to the Eurasian platform; and 11—motion of Africa and Arabia with respect to the Eurasia. Size of interpolation symbols is variable.

underthrusting of oceanic lithosphere along subhorizontal fault planes.

In brief, the constrictive stress field and deformation pattern around the Caspian Sea results from the combined effects of the N-S collision between the Arabian plate and the Russian platform, and the NNW-SSE convergence between the eastern Iranian block (Lut Block) and the Russian platform.

6.1.2 *The Gibraltar arc continental collision*

Despite the relative uniformity of the average stress field within the western Mediterranean continental collision zone, several stress deviations linked to arc structures are present (Fig. 10).

The Gibraltar arc, caught between the African plate and the Iberian block, is limited by major active strike-slip faults: the Alicante-Cadix right lateral fault to the north and the Nekor-Carboneras-Alicante left lateral fault to the south. A thrusting arcuate front associated to quaternary folds in Morocco, limits this region to the west (Fig. 12). All through the eastern part of the Gibraltar arc, S_{hmax} is roughly NNW-SSE; roughly parallel to the convergence motion. On the other hand, in the western part, close to the thrust front, S_{hmax} direction is subperpendicular to the curvature of the arc. Stress deviations follow a fan-shaped pattern which rapidly disappears and stress directions become NNW-SSE once again in the Azores-Gibraltar zone (Fig. 12). The geodynamic evolution of the Gibraltar arc corresponds to the transition between a subduction zone (active mainly during the late Cenozoic), and a collision zone. Thus, oceanic basins that existed in the Gibraltar arc were absorbed along E-W boundaries by Miocene subductions (Philip 1987). At present, only a narrow zone of this oceanic lithosphere remains in the western part of the arc. Stress deviations are localized close to this reduced free edge zone, along which the lateral movement of the Gibraltar block is absorbed. In fact, this block is pushed away to the west as a result of the collision between the African plate and the Iberian block. This stress deviation corresponds to a restricted area, in comparison to the one described in the eastern Mediterranean, where subduction zones are still active (Aegean subduction). Furthermore, while extensional tectonics dominates in the Aegean zone,

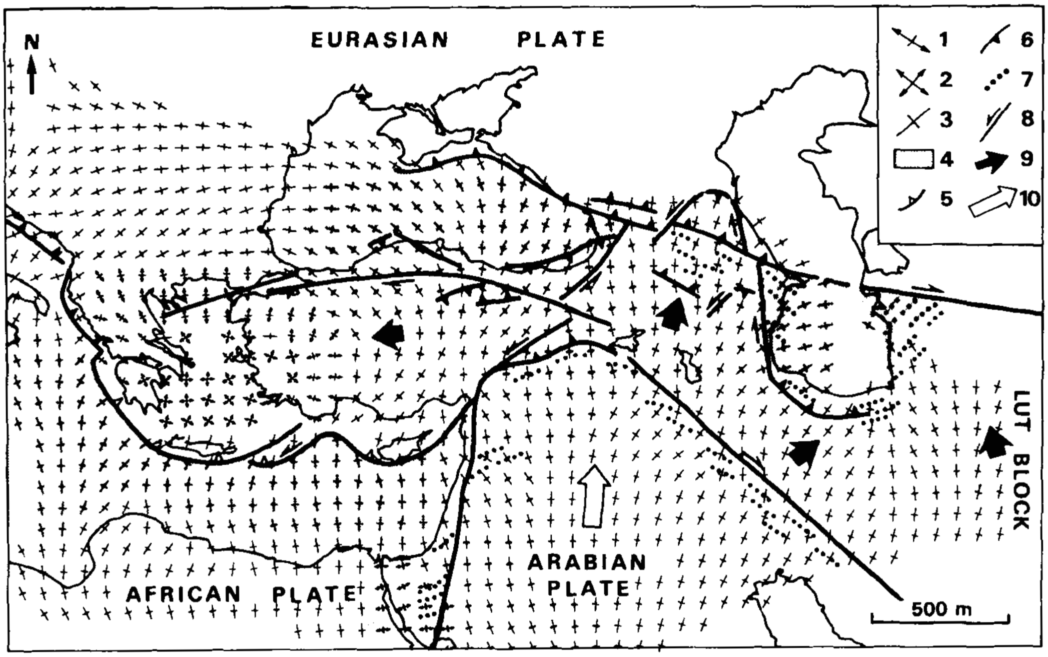

Figure 11. Interpolated map of the modern stress field in the eastern Mediterranean and Caucasian region: Aegean subduction and Caucasian continental collision. 1—Strike-slip extension tectonic context; 2—radial extension; 3—strike-slip compression; 4—oceanic crust; 5—subduction trenches; 6—reverse fault and thurst; 7—fold axis; 8—strike-slip fault; 9—block movements with respect to the Eurasian platform; 10—motion of Arabia with respect to Eurasia. Size of interpolation symbols is constant.

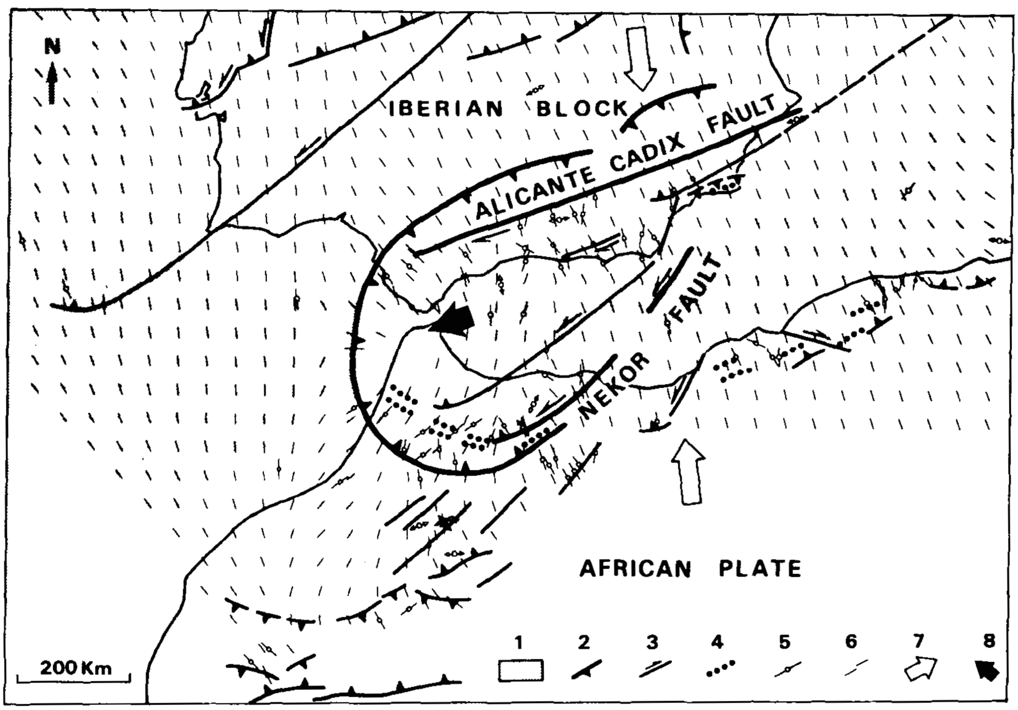

Figure 12. Modern stress field in western Mediterranean region: the continental collision between the African plate and the Iberian block. 1—Oceanic crust; 2—reverse fault; 3—strike-slip fault; 4—fold; 5—stress datum; 6—interpolated $S_{h_{max}}$ direction; 7—motion of Africa with respect to Eurasia.; 8—block movements with respect to the Eurasian platform. Size of interpolation symbols is constant.

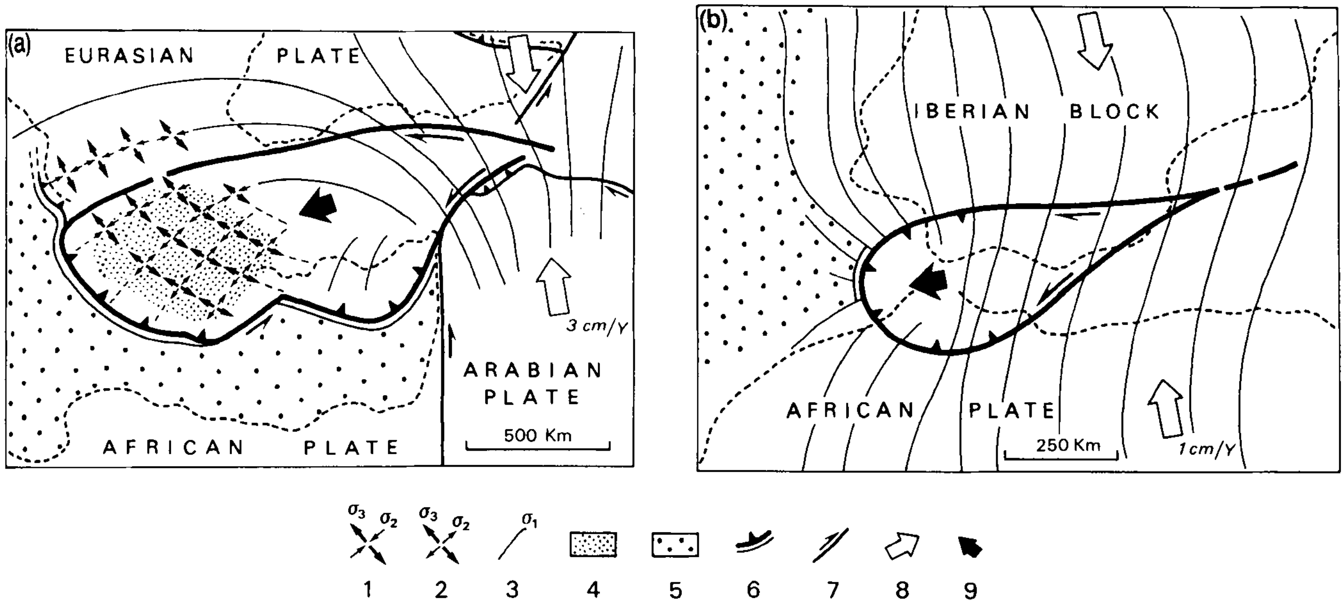

Figure 13. Stress field deviations and lateral expulsion. (a) Anatolian block; (b) arc of Gibraltar; 1—strike-slip extension; 2—radial extension; 3—strike-slip compression; 4—thinned continental crust; 5—oceanic crust; 6—subduction trench; 7—strike-slip fault; 8—converging direction of blocks; 9—block movements with respect to the Eurasian platform.

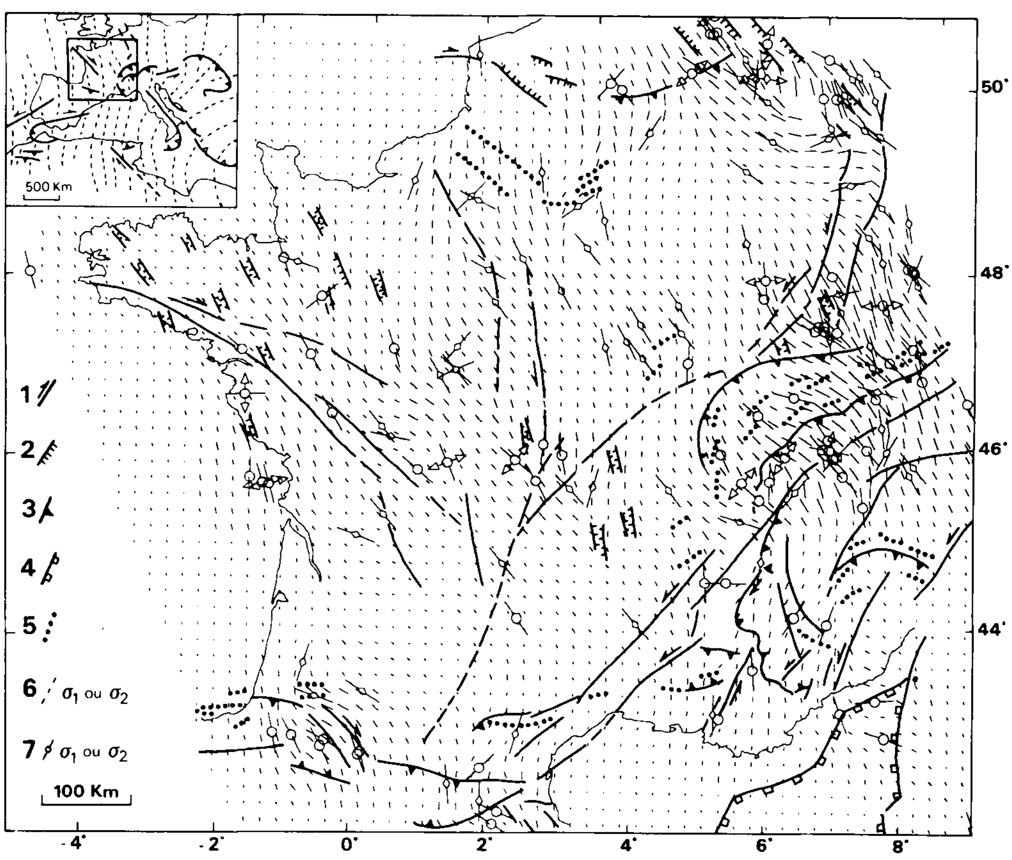

Figure 14. Modern stress field in France. 1—strike-slip fault; 2—normal fault; 3—reverse fault; 4—continental margin; 5—fold; 6—interpolated S_{hmax} direction; 7—stress datum.

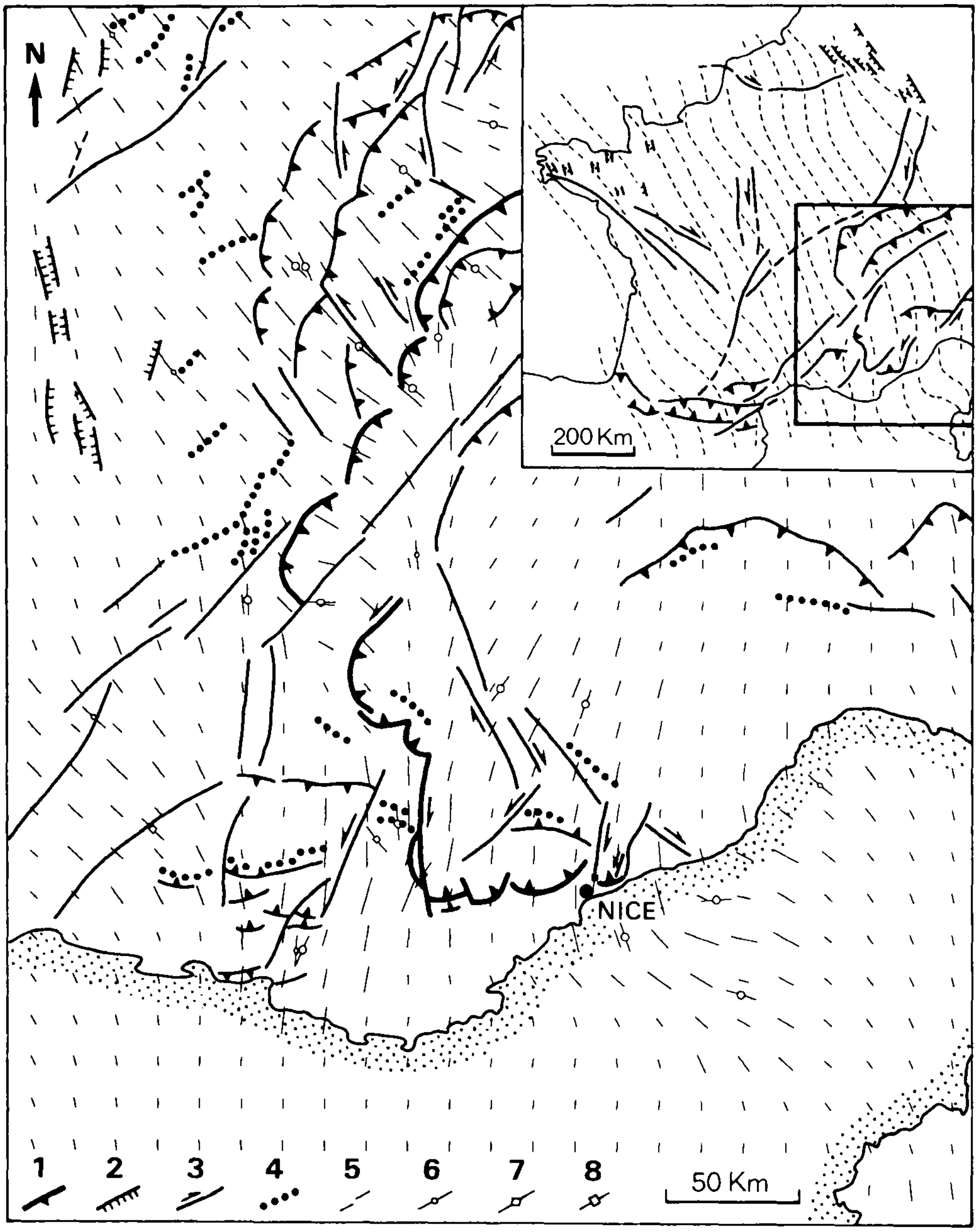

Figure 15. Modern stress field within the southern Alps. 1—Reverse fault; 2—normal fault; 3—strike-slip fault; 4—fold axis; 5—interpolated S_{hmax} direction; 6—S_{hmax} direction calculated from earthquake focal mechanisms; 7—S_{hmax} direction deduced from *in situ* stress measurements; 8—S_{hmax} direction deduced from microtectonic analysis.

the tectonic context within the Gibraltar arc is mainly compressive (Fig. 13).

These examples also show that stress directions can be either subperpendicular or subparallel to main lithospheric boundaries: S_{hmax} is subparallel to the north Anatolian right lateral fault (Fig. 13a), and subperpendicular to the Alicante-Cadix right lateral fault (Fig. 13b). This implies that the resolved shear stress on these faults is quite low and suggests that, as in the case of the San Andreas fault (Zoback 1991), they behave as weak transform faults.

6.2 Example of stress deviations at different scales

To illustrate the existence of local stress deviations, we present an analysis of the average stress field for the same region at different scales.

As shown previously in Fig. 10, the stress field in France at plate scale seems to be relatively uniform. Small stress deviations are only present within the Alps and the Pyrenees. However, a more detailed scale map (Fig. 14), permits identification of other stress deviations, while those mentioned previously become clearer. These minor stress deviations are associated with smaller faults as shown in Fig. 14. Domains where stress field is relatively uniform (roughly NNW–SSE) correspond generally to peri-alpine continental platforms, whereas those where stress deviations are present correspond to recent mountain belts and crustal scale faults (Alps, Pyrenees, Jura, Provence, etc.) For example, within the Alpin arc, the average S_{hmax} direction is not uniform: whereas S_{hmax} is N–S to NNE–SSW in the southern Alps and in Provence, it becomes E–W in the

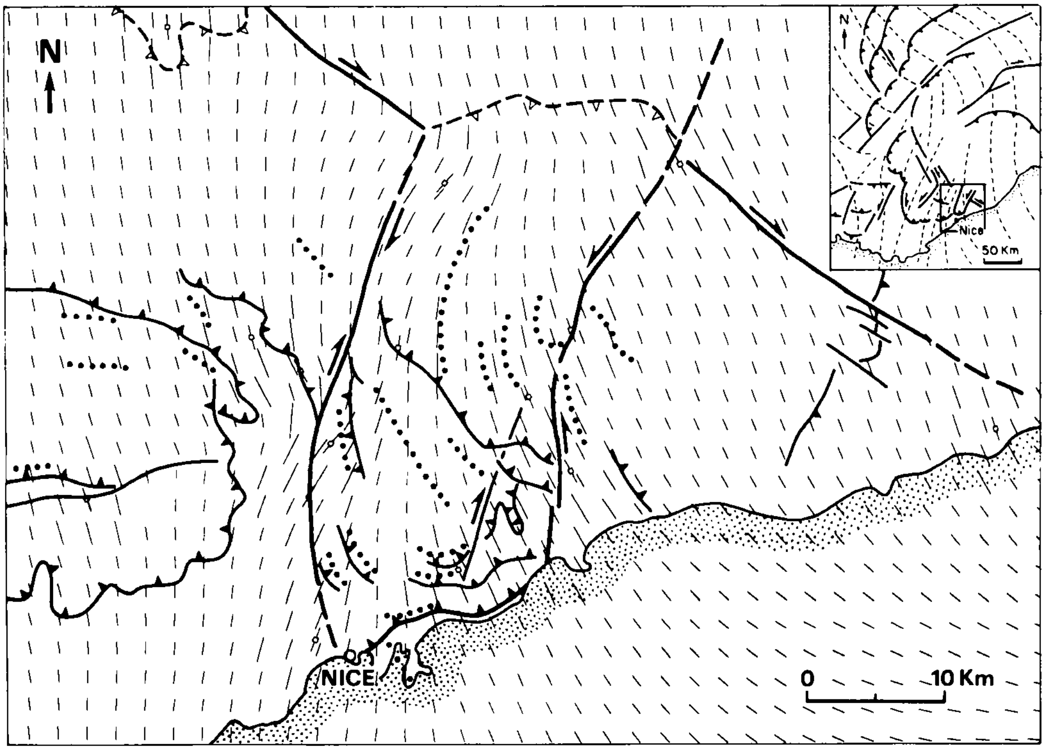

Figure 16. Quaternary stress field within the 'Arc de Nice' (French southern Alps). The stress field has been calculated from microtectonic data (from Ritz 1985 and Rebaï 1987).

Belledonne massif and then NW–SE in the Jura and in the Swiss Alps (Fig. 15).

The average stress field in the southern Alps reveals several stress deviations at regional scale. For instance, within the Arc de Nice, the stress field uniform at the Alps scale (Fig. 15) presents several deviations when it is considered at a more detailed scale (Fig. 16). Within the Arc de Nice, the S_{hmax} direction is NNE–SSE along the Breil–Sospel–Monaco left lateral strike–slip and becomes N-S, the NNE–SSW along the Nice–Aspremont–St Blaise right lateral strike–slip fault. Here again, the S_{hmax} direction follows a fan-shaped pattern (Fig. 16). This stress pattern is consistent with the geodynamic and tectonic model of evolution of the Arc de Nice (Ritz, 1986; Rebaï 1988; Ritz *et al.* 1990).

This example shows that in regions where stress deviations are present, the stress field varies from one scale to another. In fact, as the scale of observation becomes more detailed, the stress field becomes more complex and displays deviations which are not revealed at larger scales. Nevertheless, the stress field at any given scale is consistent with fault kinematics and deformations at this scale.

7 CONCLUSIONS

Caught between the converging African and Eurasian plates, the Mediterranean region displays a relatively complex stress field pattern, despite the relative simplicity of far field boundary conditions. The analysis of the stress field in this region is consistent with models involving microblocks of variable strengths, sizes and geometries. The arrangement and kinematics of microblocks in a globally convergent system lead to a large variety of geodynamic situations of restricted amplitude (collision, lateral expulsion and subduction). The state of stress depends on these geodynamic situations. Thickened continental collision zones (i.e. Caucasus, Alps and Pyrenees) are mainly subjected to compressive tectonics, and thinned continental zones (i.e. Aegean and Tyrrhenean back-arc basins) localize mainly extensional tectonics. Internal deformation of microblocks can be quite important; consequently, stress deviations at different scales are currently observed within microblocks. Conversely, oceanic lithospheres (either old: Mesozoic, or more recent: Oligo–Pliocene) are poorly deformed. The stress field inside oceanic lithospheres seems to be quite homogeneous.

Several examples of average stress field patterns at different scales have been examined. They illustrate how the average stress field at a given scale is consistent with geological structures of the same scale, and not necessarily compatible with the kinematics of larger or smaller-scale faults. This means that discontinuities (faults) and heterogeneities at a given scale are associated with stress deviations of the same scale.

The results of this study are useful to understand better the relationship between the active structure geometries, the modern stress field and surface deformations (neotectonics). Furthermore, they emphasize the predictive character of this study. For example, we can work out the focal mechanism of a probable earthquake on an active fault.

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APPENDIX: REFERENCES OF STRESS INDICATORS DATA

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