

CONTENTS

PREFACE.....	VII
1. INTRODUCTION.....	1
2. VARIOUS TOPICS IN SEISMOLOGY – TECTONICS PERTAINING TO EQ PREDICTION.....	5
2.1.Spatial distribution of strong EQs.....	5
2.1.1. Mapping of major seismic fracture zones – faults.	7
2.1.2. Mapping of major seismic fracture zones - faults from the study of the earth's gravity field.	10
2.1.3. Application of the methodology in Greece.	12
2.1.4. Strong EQs location map of Greece (1901-1997).	17
2.1.5. Verification of fault zones by strong EQs, which occurred in the period of time 1998-2006.	20
2.2. Depth distribution of strong EQs	22
2.2.1. Number of EQs as a function of occurrence depth for a fixed magnitude of 5.5 R. ..	26
2.2.2. Number of EQs as a function of occurrence depth for a fixed magnitude of 6.0 R. ..	26
2.2.3. Number of EQs as a function of occurrence depth for a fixed magnitude of 6.5 R. ..	26
2.2.4. Number of EQs as a function of occurrence depth for a fixed magnitude of 7.0 R ...	27
2.2.5. Number of EQs as a function of occurrence depth for a fixed magnitude of 7.5 R ...	28
2.2.6. Number of EQs as a function of magnitude for a fixed depth of 0, 5, 10 Km.....	28
2.2.7. Number of EQs as a function of magnitude for a fixed depth of 100 Km.....	29
2.3. Seismic energy density at distance (X) from the focal area.....	29
2.4. Electrical resistivity lithospheric model.....	32
2.5. Physical models used in this methodology.....	35
2.5.1. The lithospheric seismic energy flow model.....	37
2.5.1.1. Theoretical analysis.....	37
2.5.1.2. Application of the model on cases of real EQ	39
2.5.1.2.1. Application of the theoretical model on the EQ in Zakynthos (02/12/2002, Ms = 5.8R).....	42
2.5.1.2.2. Application of the theoretical model on the EQ in Kythira (08/01/2006, Ms = 6.9R).....	46
2.5.2. The lithospheric plate oscillation model.	52
2.5.3. The homogeneous ground Earth model.....	57

3. GENERATION OF ELECTRICAL SIGNALS	61
3.1. Streaming - electrokinetic potentials model.....	63
3.2. Perturbation of the electric current by a resistivity anomaly.....	63
3.3. Single rock fracturing model.....	64
3.4. Piezostimulated model.....	64
3.5. Piezoelectric model.....	65
3.6. Ionospheric induction model.....	66
3.7. Local piezoelectricity activation.....	66
3.8. Displacement of charged dislocations.....	66
3.9. Potential gradients generated due to the presence of long-range stress.....	67
3.10. Magmatic mechanism of shallow crustal preparation of an EQ	67
3.11. The deformation induced charged flow (DICF) model.....	67
3.12. Pulsed charge model.....	67
3.13. Multiple fractures model.....	67
3.14. Electromagnetic emission model, related to dislocation dynamics.....	68
3.15. Triggering of positive hole-pairs (PHP).....	68
3.16. Seismic, precursory, electric signals samples.....	69
3.16.1. SES, precursory, seismic electric signals.....	73
3.16.2. Oscillatory type earthquake precursory, electrical signals.....	80
3.16.3. Very Long Period (VLP, plateau-like), seismic, precursory signals.....	83
4. EQ PROGNOSTIC PARAMETERS DETERMINATION.....	87
4.1. Time of EQ occurrence determination.....	88
4.1.1. The mass - friction interaction model.....	89
4.1.2. Tidal forces acting upon the lithosphere.....	93
4.1.3. Generation of Earth Tide Values.....	96
4.1.4. Seismicity compared with a year's period earth-tide wave.....	98
4.1.5. Seismicity compared with the 14 days period lithospheric oscillation.....	99
4.1.6. Daily earth-tide oscillation, correlated to same day seismicity (29/05/2001).....	100
4.1.7. Examples of "a posteriori" correlation of earth-tide waves to seismicity.....	100
4.1.8. Statistical test of seismicity to 14days tidal oscillation.....	101
4.1.9. Statistical test of seismicity to daily tidal oscillation.....	102
4.1.10. Electrical signals timing compared to lithospheric tidal oscillations.	109
a. SES, (Seismic Electric Signals) or "high frequency" signals.....	109
SES generated by the Izmit, Turkey (17/8/1999, M=7.5) EQ.....	109
SES signals recorded by HIO monitoring site, compared to 14 days	
period tidal lithospheric oscillation.....	112
SES signals recorded by PYR monitoring site, compared to 14 days	

period tidal lithospheric oscillation.....	117
SES signals recorded by ATH monitoring site, compared to 14 days	
period tidal lithospheric oscillation.....	118
b. Oscillatory type earthquake precursory signals.....	124
c. VLP signals.....	132
4.2. Epicenter area determination.....	135
4.2.1. Basic assumptions.....	136
4.2.2. Preseismic signals amplitude in terms of their period / frequency.....	139
4.2.3. What is actually measured.....	142
4.2.4. Preseismic signals normalization.....	147
4.2.5. Preseismic electric signal processing.....	154
4.2.5.1. Data file editing for missing data.....	154
4.2.5.2. Noise rejection methodologies and filtering applied on data sets.....	156
4.2.5.2.1. Running a moving average (equally weighted or not).....	156
4.2.5.2.2. Polynomial fitting.....	156
4.2.5.2.3. Fast Fourier Transform (FFT).....	156
4.2.5.2.4. Magnetotelluric impedance tensor.....	160
4.2.5.2.5. Noise injection methodology for a time series data filtering.....	162
4.2.5.6. Preseismic electrical signal identification.....	171
4.2.7. Basic principles of current flow in the ground.....	173
4.2.8. Azimuthal direction determination.....	178
4.2.9. Multidirectional oscillating electrical field analysis.....	188
4.2.9.1. The theoretical model.....	188
4.2.9.2. Electrical field orthogonal components, which have been generated by different current sources	190
4.2.9.3. Electrical field orthogonal components, which have been generated by the same current source.....	190
4.2.9.4. Electrical field orthogonal components, which have been generated by the same current source and correspond to a local electrical field anomaly.....	191
4.2.9.5. Electrical field orthogonal components, which have been generated by the interference of more than one current sources.....	192
4.2.9.6. Real data analysis.....	193
4.2.9.6.a Determination of the azimuthal direction of a specific period of time electrical field recording vs. concurrent seismicity.....	194
- Time span – recorded orthogonal components.....	194
- Polar diagram construction.....	194
- Seismicity map, compared to the calculated polar diagram.....	195

4.2.9.6.b Other examples.....	195
Example – 1	195
Example – 2	197
Example – 3	198
Example – 4	200
4.2.10.Triangulation of preseismic electrical signals.....	201
4.2.11.Ionospherically induced noise rejection.....	206
4.2.12.Virtual epicenter area determination. The “Common Point Method (CPM)”.....	209
4.2.13.Application on real earthquakes (epicenter determination).....	215
4.2.13.a Earlier work from Thanassoulas (1991).....	215
4.2.13.b Recent examples from the currently in operation network.....	218
Zakynthos, Greece, 20060404, Ms = 5.7 EQ.....	218
East Kythira, Greece, 20060108, Ms = 6.9 EQ.....	222
West Turkey, 20051017, Ms = 6.0 EQ.....	224
SW Kythira, Greece, 20031017, Ms = 5.8 EQ.....	227
Lefkada, Greece, 20030814, Ms = 6.3 EQ.....	229
Saros Bay, Turkey, 20030706, Ms = 5.9 EQ.....	232
4.2.14. Some more concluding remarks on epicenter determination.....	234
4.3. Magnitude determination.....	239
4.3.1. Introduction.....	239
4.3.2. Theoretical model analysis.....	240
4.3.3. Statistical validation test of the methodology.....	245
4.3.4. Explanation of the achieved accuracy.....	247
4.3.5. Examples of the application of the methodology on real EQs.....	249
4.3.5.a. Skyros, Greece, 26 th July 2001, Ms = 6.1 R.....	249
4.3.5.b. Northridge EQ, California, USA, 17/1/1994, M = 6.7 R.....	251
4.3.5.c. Parkfield EQ, California, USA, 28/9/2004, Mw = 6.0 R.....	252
4.3.6. The “BIG ONE” expected earthquake in California.....	254
4.3.6.1. Los Angeles area.....	254
4.3.6.2. Southern California area.....	255
4.3.6.3. San Francisco area.....	257
4.3.6.4. Northern California area.....	258
4.3.7. Some different seismological applications of the “Lithospheric Seismic Energy Flow Model (LSEFM)”.....	260
4.3.7.1. Accelerated seismic energy release and deformation.....	260
- Zakynthos EQ example.....	262
- Seismogenic area (A) example.....	266
4.3.7.2. The “Seismic potential map”. Its application example in Greece.....	270

A. The data.....	272
B. Application of the method – examples.....	273
C. Discussion – Conclusions.....	285
5. INTEGRATED EXAMPLES FROM REAL EQs.....	291
5.1. Zakynthos, Greece, 04/04/2006, Ms = 5.7 R.....	292
5.2. East of Kythira, Greece, 08/01/2006, Ms = 6.9 R.....	293
5.3. South of Crete, Greece, 24/11/2003, Ms = 5.1 R.....	295
5.4. Lefkada, Greece, 14/8/2003, Ms = 6.4 R.....	297
5.5. Skyros, Greece, 26/7/2001, Ms = 6.1 R.....	299
6. IMPLEMENTATION OF THE METHOD.....	303
7. OVERALL CONCLUSIONS.....	305
8. OTHER SEISMOLOGICAL TOPICS. THE AEGEAN MICRO – PLATE ROTATION.....	309
8.1. Introduction.....	309
8.2. The theoretical model.....	315
8.2.a. The rotational moment model.....	315
8.2.b. The thrust model.....	317
8.3. Forces applied on the Aegean micro-plate.....	318
8.4. Morphological data.....	319
8.5. Volcanic data.....	321
8.6. Geophysical paleomagnetic data.....	323
8.7. Geophysical gravity data.....	324
8.7.1. Gravity deduced fracture zones.....	324
8.7.1.1. Circular fracture zones.....	325
8.7.1.2. Radial fracture zones.....	325
8.8. Seismic data.....	328
8.9. The postulated kinematic Aegean micro-plate model.....	332
8.10. Conclusions.....	333
9. REFERENCES.....	339
10. PRESENT NETWORK.....	355
11. NETWORK TO BE INSTALLED.....	359
12. HARDWARE PRESENTATION.....	361
12.1. Block diagram of the monitoring site hardware.....	361
12.2. Section A. Receiving dipoles.....	362
12.2.1. Electrodes used.....	362

12.2.1.1. Non-polarizing electrodes	362
12.2.1.2. Borehole metal casing	363
12.2.2. Cables layout	364
12.3. Section B. Signal pre - conditioning unit	365
12.3.1. Power supply.....	366
12.3.2. Front end	366
12.3.3. Optoisolator.	367
12.3.4. Low-pass, band-pass filters.	368
12.3.4.a. Low pass active filter.	368
12.3.4.b. Band pass active filter.	368
12.3.5. Signal amplification.	369
12.4. Section C. Desktop computer.	371
12.4.1. Analog to digital conversion card	371
12.4.2. Desktop computer.	371
12.5. Modem.	372
13. DATA DESCRIPTION CONTAINED IN CD.	373
13.1. Map of Greece.	373
13.2. Geographical coordinates of the three (PYR, ATH, HIO) monitoring sites.	373
13.3. Dipole length, azimuthal direction and their polarity.	373
13.4. Format of registered preseismic electrical signals raw data.....	373
13.5. Data files of registrations from PYR, ATH, HIO monitoring sites.....	373
13.6. Format of earthquake catalog file.....	373
13.7. Earthquake catalog file of the seismicity of Greece (1901 till the day of publication of this book).....	373
13.8. Format of data file of magnetic field.	373
13.9. Data files of the magnetic field variations observed at Magnetic Observatory of Penteli (MOP), Athens, Greece.	373

