Under the aegis of the President of the Hellenic Republic

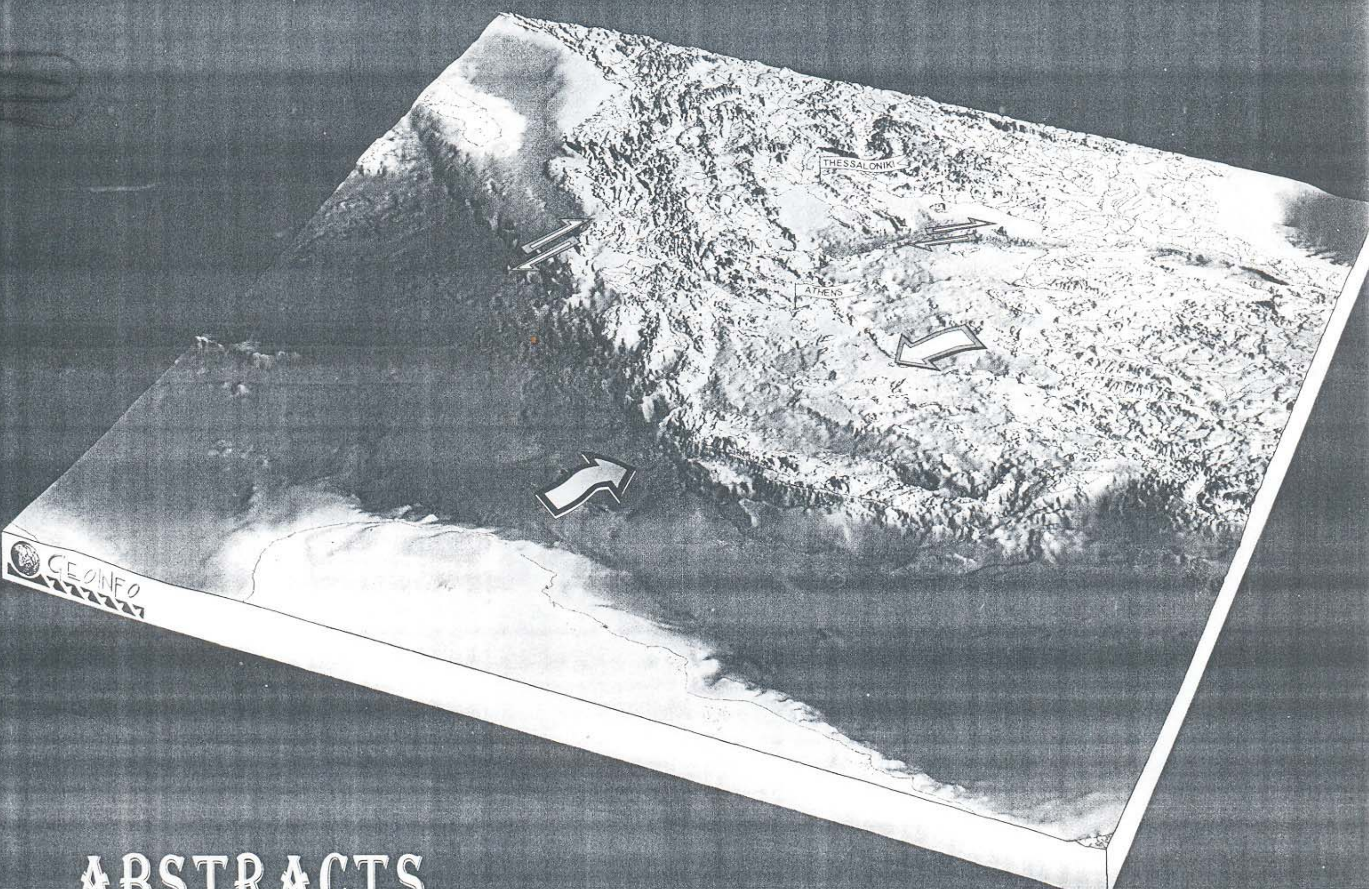
IASPEI 1997

August 18 - 28, 1997
Thessaloniki, Greece

THE 29TH GENERAL ASSEMBLY

OF THE

INTERNATIONAL ASSOCIATION of SEISMOLOGY and PHYSICS of the EARTH'S INTERIOR



ABSTRACTS

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WORKSHOP W8

Recent Strong Earthquakes in European-Mediterranean Region

POSTER

Convener : K. Macropoulos (Greece)
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2447 **Field Study of the Racha-Dzhava (Georgia) 1991 Earthquake Mechanism: Aftershocks and Body Wave Inversion. A Case of Active Nappe Tectonics**

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The April 29 1991 Racha earthquake in the southern border of western Great Caucasus is the biggest event ever recorded in the region. Three aftershocks followed: April 29th at 18:30 (M_s=6.1), May 5th at 20:19 (M_s=5.4) and June 15th at 00:59 (M_s=6.2). A field expedition to the epicentral area was organized and a temporary seismic network of 37 stations was deployed to record aftershock activity. A precise image of the aftershock distribution is obtained, showing an elongated cloud oriented N105 with one branch trending N310 in the western part. The southernmost part extends over 80 km with depth ranging from 0 to 15 km and dipping north. The northern branch of 30 km long presents activity from 5 to 15 kilometers of depth. This represents a north dipping structure. A triaxial compression was found with the major principal axis oriented roughly NS, the minor principal axis being vertical. The resulting stress tensor explains 89% of the polarities with a likelihood of 93.8%. The main shock is modelled by four subevents with total rupture time duration of 22 seconds. The principal subevent (phi=286.7,delta=29.0, lambda=92.4) corresponds to 72% of the total scalar seismic moment. The remaining part of the moment release is shared by a foreshock and two secondary sources. The mainshock was preceded by a foreshock. The source has an average depth of 4.8 km, most of the seismic moment being released by a gentle northerly dipping thrust. The two latter events of the main rupture correspond to a thrust and to a strike-slip event, located 20 km to the north-west and 20 km to the west respectively. All mechanisms agree with the compressive tectonics of the region, with the aftershock distribution and with the stress tensor deduced from the aftershocks.

1267 **Correlation of Damages and Seismic Faults in Recent Earthquakes**

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Both in the Mediterranean and on a worldwide basis some earthquakes, characterized by small epicentral distances from urban centers and the significant damages they have generated, have occurred recently.

The shocks in question include Ms=5.5R earthquake in Pyrgos (26 March 1993, Greece), the Ms=6.1R earthquake in Egion (15 June1995, Greece), the Ms=6.1R earthquake in Dinar (1 October 1995, Turkey) and finally the Ms=7.2R earthquake in Kobe (17 January 1995, Japan).

The aforementioned mainshocks had additional characteristics in common: their focal depths were small, not exceeding 15-20km; a number of seismic faults, which bisected the urban areas, occurred on the surface, and finally, they generated a group of secondary phenomena.

By comparing the existing data, the magnitude of each earthquake is estimated to have been proportional to the size of the seismic ruptures on the surface as well as to the displacement of the blocks on either side of the faults. For instance, in Kobe, the length of the seismic fault is said to be approximately 20km while the displacement exceeded 1.5m; in Dinar the length was 11km and the displacement reached 0.40m in Egion, the length was approximately 2km and the displacement reached 3cm; finally in Pyrgos, the length was 100 - 200m and the displacement reached 1 - 2cm.

The geographical distribution of the damage produced only by the shock and not the secondary geodynamic phenomena was strictly linear. This was most evident in the case of shocks which were accompanied by seismic faults of a greater length and block displacement. On the contrary, the linear distribution was less apparent in the shocks which were accompanied by shorter faults and block displacement.

1308 Seismic Regimes Interaction Analysis by Influence Matrices Method

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A method of seismic regime investigation is suggested, which is based on estimating the relative values of Poissonian, self- and mutual-exciting parts of seismic process intensity in a given region with respect to influence of other regions, either surrounding the considered one or being far from it. The method uses estimation of parametric models of intensity by maximum likelihood approach. Necessary conditions of maximum give a convenient way to normalize the influence parts of each intensity component and formalize a notion of influence matrix A(i,j), i=1,...,m; j=0,1,...,m, where m is a number of regions to be considered. Rows of this matrix are composed of nonnegative values, having the unit sum. Value of A(i,0) could be interpreted as Poissonian share into the mean intensity of i-th region, A(i,i) - as self-exciting and A(i,j), i not equals j - as mutual-exciting (influence j→i) shares. By estimating the influence matrix in an overlapping moving time windows a temporal changeability of relations between different seismic regions could be inspected. The method is applying to seismic regimes of California, Carpato-Balkan region and Japan. Research was supported by INTAS grant 94-0232.

1269 Earthquake Emergency Planning Based on G.I.S. the Example of Lindos Town (Rhodes,Greece)

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An integrated approach to seismic risk management requires a huge amount of data from various scientific disciplines to be correlated quickly, accurately and cost - effectively. GIS are not only useful designing tools for map representation but they can also be applied for data processing and coordination of a multidisciplinary study. They can therefore provide the means for effective decision making.

In order to make the most of GIS capabilities, a map of emergency organization and planning was complied and is presented here, aiming to seismic risk reduction with respect to earthquake to earthquake primary and secondary effects. The software package used for the project was the W/S Arc/Info.

In Lindos town, (Rhodes island) a number of special conditions and parameters, which are induced by the high seismic risk, may be critical for the success of any earthquake emergency planning program and should be evaluated in close relation to the contemporary social and economic status. Hence, the number and distribution of deaths and the social impact, in general, are greatly determined by the following factors: (I) geologically active and seismic faults run, through the area in question, (ii) earthquake - induced hazard are highly probable given the geology and the topography of the town and the coastal area, (iii) the building environment and infrastructure are unique (including a number of imposing houses, classical antiquities and mediaeval remains) and (iv) seasonal changes in people's lifestyles.

The final goal of the project is the development of a computer model which evaluates the seismic risk and can therefore be used for decision-making on land and for the elaboration of emergency plans. By means of simulations of emergency action scenarios, public awareness will be developed and the operational effectiveness of the relevant public bodies will be stimulated, thus minimizing the impact of a disaster.

1327 Zoning of Urbanized Territories According to Stability of the Geological Environment With the Aim of Forecasting the Integral Seismic Risk

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Under the stability of Geological environment of urbanized territories the ability is understood to adapt to cyclic (seismic, vibrational) and static (the influence of the technogenous complex) loads during the whole period of the life cycle of building and constructions which changed the initial structure, state and properties of the geological environment. The stability of the geological environment depends upon the two groups of factors, the first determining the initial quality of the geological environment, the second - the character of technogenous loads. The load level are described by a number of limits, such as geostatic, stability limit, the limit of balance, the limit of firmness.

Depending upon the character of technogenous changes and the initial state of the geological environment the latter can be characterized by one of the states: guaranteed long-term stability (1), unstable balance (2), firmness - long-term (3a) or short-term (3b), the state of complete loss of stability (4) and the state of avalanche-like unpreventable destruction (5). The value of seismic risks in some or other area can be forecasted subject to the state of the geological environment, which, in its turn, determines the second component of structure vulnerability (the first component is traditionally linked with the factors of construction). The state of the geological environment is able to change under the impact of environmental factors. Thus, the integral evaluation of seismic risk should be corrected depending upon the range of stability characteristics of the geological environment.

1360 Seismic Zonation for Fennoscandia; Preliminary Results

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The seismic hazard for Fennoscandia has been estimated by a probabilistic method based on a seismic zonation where altogether 28 seismic provinces/zones were defined. The seismicity catalog used was carefully analyzed, and only reports from the most reliable sources were used. All magnitudes were converted to moment magnitudes, where the results of an analysis of North European earthquakes, indicating that M_s equals M_w for most of the magnitude range, was applied.

For the whole of Fennoscandia as well as for each zone, the seimic activity parameters a, b and N in the cumulative Gutenberg Richter relation were estimated. This was done by means of regressions where sufficient data existed, and by means of expert opinion combined with data review where the available data are sparse. A b-value of 1.15 was found appropriate for the whole region and was fixed for all of the subregions.

The attenuation relation used has been developed specifically for Norwegian regions, and is based on Norwegian data.

The results are presented in terms of Peak Ground Acelleration (PGA) values at different probability levels, and the results indicate the highest seismic hazard values on the Norwegian continental shelf, and the lowest values in Denmark and Finland.

1643 Inverting Earthquake Spectra for the Focal Mechanism

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Displacement spectra below the corner frequency are insensitive to the source time function. This allows us to determine components of the seismic moment tensor without determining its time variation. Such a focal-mechanism estimation is advanatgeous because of its robustness, i.e. weak sensistivity to unknown structural details. The method requires complex spectra below the corner frequency to be known at a few frequencies (as low as possible without instrumental distortion), at a very few stations. Mixing the components is possible . No previous separation of the individual waves is required, i.e. the spectra of the whole record are processed, possibly including also the near-field effects. This is because the Green's tensor (and its spatial derivatives) are calculated as a complete wave solution for an assumed (approximate) horizontally layered crustal model and an assumed depth by the Discrete- Wavenumber method. We work at few low frequencies only,hence the necessary DW calculations are very fast. The theoretical Green's function spectrum, the measured real and imaginary components of the ground-motion spectra, and the unknown components of the moment tensor are related by the point- source representation theorem. The inverse problem is overdetermined, and solved in the least-square sense. The assumed focal depth can be improved by recalculating the Green's tensor for several depths, and minimizing the residuals.The method has been validated by synthetic tests, and Corinth Gulf (Greece) earthquakes, recorded by the seismic network of the Patras University, for which the focal mechanisms were previously determined by independent methods.

Acknowledgement: Work supported by NATO SfS GR-COAL grant, the Czech Rep. Agency grant 205/1743, and Copernicus grants ISMOD and COME.

1720 Smoothed Source Time Function - A Tool for Inversion of Noisy and Inconsistent Seismograms?

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Inconsistency of observed seismic records and synthetic seismograms originated by noise contamination of the data and/or by improper Green function due to inexact structural model often results in high frequency oscillations of the source time function which prolongs in spuriously.
A priori limit of smoothness of the source time function was proved to eliminate the spurious oscillations and, simultaneously, to provide better approximation of the mechanism than from an unlimited solution but it keeps its improper extension unchanged. Thus, it may yield a severe distorted seismic moment. Demand for the smoothness is incorporated as a penalty function in minimization of the least square residuals which allows us to decide about the degree of the smoothness. The minimization is performed with a simple genetic algorithm, which offers advantage of detailed exploration of the model space reducing the danger of being trapped in local minima.

1268 Determination of the Expected Seismic Magnitude of the Vounargo Fault Zone (W. Peloponnese-Greece)

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Western Peloponnese is characterised by increased seismicity on account of intense geotectonic activities which occur underground. Especially the area of the Ilia graben, which covers a surface of over 2000 km^2, is characterized by the presence of a great number of faults which have been reactivated repeatedly since Pliocene.

Vounargo fault zone, which is a predominant structure, has played a major role in the neotectonic structure and evolution of the region. It consists of more than five faults; it is accompanied by important morphological scarps, and differentiates the neotectonic structure at either side. Its strike is ENE-WSW; its length is approximately 40 km and its total maximum offset it 500 m.

Based on geological data, such as displacements of characteristic formations in various geological periods, interpretation of the geophysical data, and evaluation of the borehole data, an average slip ratio of 0.3 cm/year has been estimated.

By combining this geological piece of information with the seismological data, (earthquakes related to this particular fault) and by applying the Bayes model, we were able to estimate the expected earthquake magnitudes which can be produced by the fault in question in the following 10, 50, 100 and 1000 years, as shown in the following table:

Repeat Time (years)	Annual Exceeding Probability	Magnitude
10	0.095	4.2-4.7
50	0.020	4.8-5.3
100	0.010	5.1-5.6
1000	0.001	5.9-6.4

1932 The Size of an Earthquake Source: Zone of Rupturing and Zone of Preparing of This Rupture

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We considered a possibility to examine an earthquake source by the wave record on a seismogram in the interval from the first arrival to the maximum oscillation phase $(A/T)_{max}$ in P-wave.

Rupture directions and extent (L_R) for the earthquakes of the Alpine zone were determined by azimuthal travel-time curves t_{pi} = f($Az°$), Δ = const. Correlation relations between dislocation length on the Earth' s surface and L_R were found for the strongest earthquakes.

Source dimensions according to Brune (r_o)turned out to be on the average 6 times below L_R value for the local earthquakes of the Black Sea. We believe that L_R characterizes the medium volume producing seismic radiation. The new method provides additional data on earthquake sources.