Earth's tides influence on the seismicity fine structure in the Ibero-Maghrebian region

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As it is well known from observations, very weak natural and artifical events affect the seismicity: atmospheric pressure changes, 11-years cicles of sun activity; loading of artifical reservoirs and underground nuclear explosions influence is distinguished in fine structure of earthquakes origin time distribution. Influence of earth's tides on earthquakes has been studied for a long time but obtained results were rather smooth and contradictory.

Method used in our study includes the theoretical calculations of tidal stress components — vertical, horizontal and whole vector and comparison of earthquake numbers within small areas which occured during the period of tidal compression and tension respectively. If earthquakes do not depend upon tidal stress, the probability of earthquake occurence in the phases of compression and tension must be equal to 0.5 and number of events N_+ and N_- happened during the time of compression and tension must be more or less equal. If the difference between N_+ and N_- is significant, it shows that earthquake occurence times are dominantly in some phase. The statistical confidence is estimated by the value of $(N_+ - N_-) / 2\delta$, where δ is the standart deviation of the binomial distribution N, if earthquakes do not depend on earth tides. If this value is 1, for example, that means that probability of dependency is 0.68, if 2 – is 0.95; if 2.5 – is 0.987.

This method may use the information of earthquakes in a wide magnitude range containing in bulletins. Study conducted for different regions: Central Asia, China, Greece; aftershock's series for Spitak (1988) and Rachin (1991) earthquakes in Armenia and Georgia show that the normalized differences $(N_+ - N_-)/2\delta$ demonstrate the contrast of earth's tide effect manifestation, differ spatially in a broad limits both negative and positive. This geographical distribution indicates the dominat stress state in different areas, because the probability of earthquake occurence must increase when tidal stress interferes constructivly with tectonic stress of preparing earthquake [1,2].

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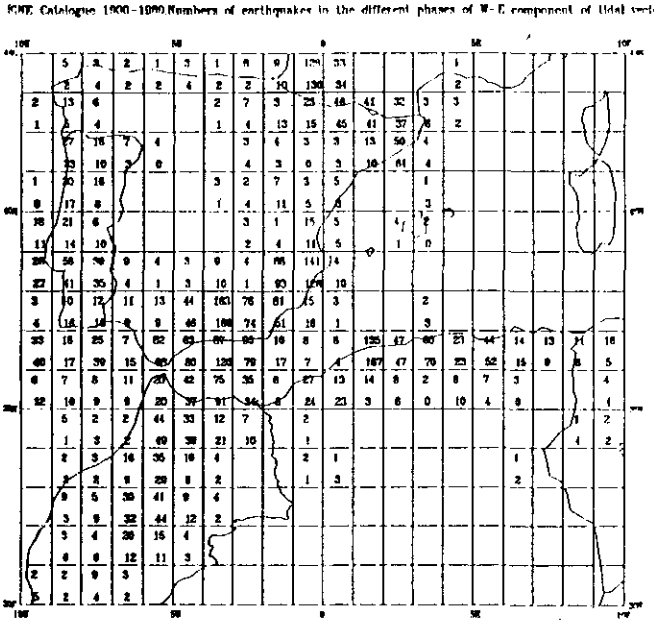

Figure 1. The map of number of the earthquakes occurred during tidal phases of compression(top and tension(bottom).

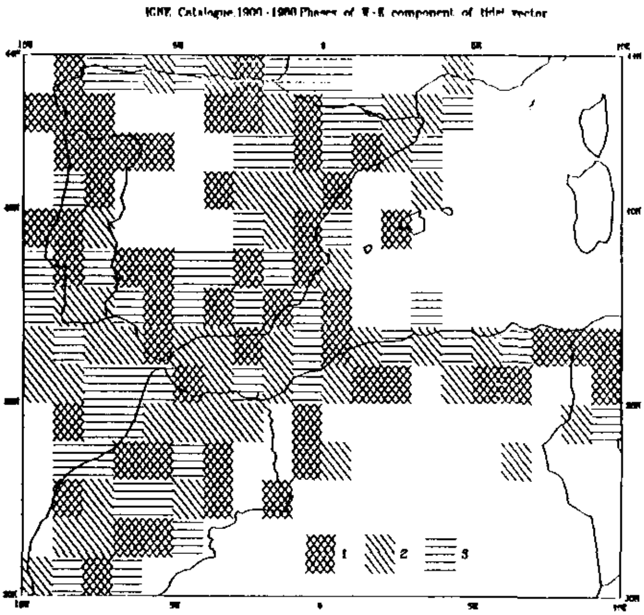

Figure 2. The map of the state of W-E stress: 1) compression, 2) tension, 3) neutral.

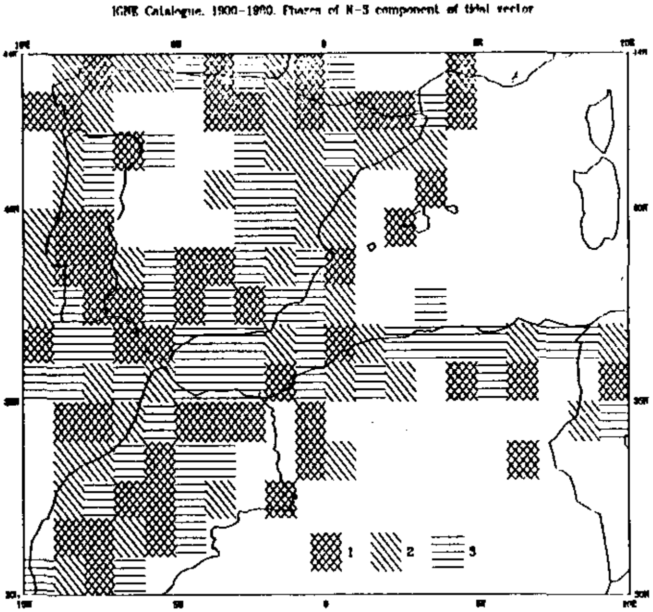

Figure 3. The map of the state of N-S stress: 1) compression, 2) tension, 3) neutral.

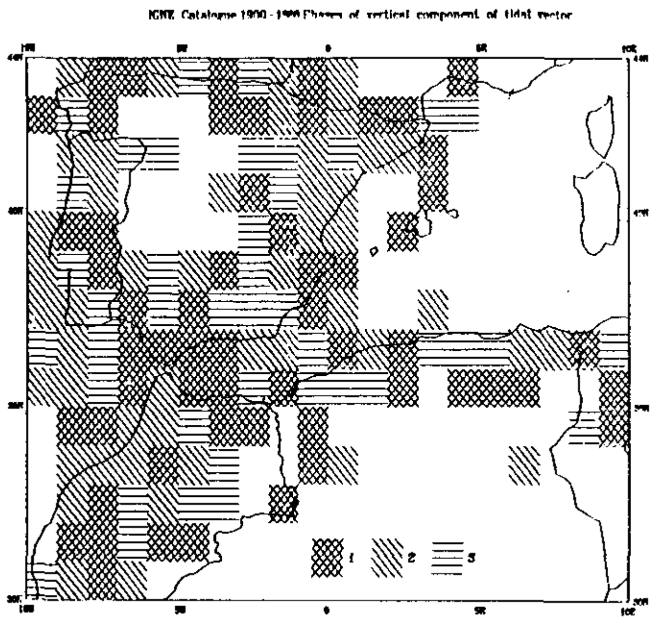

Figure 4. The map of the state of vertical stress: 1) compression, 2) tension, 3) neutral.

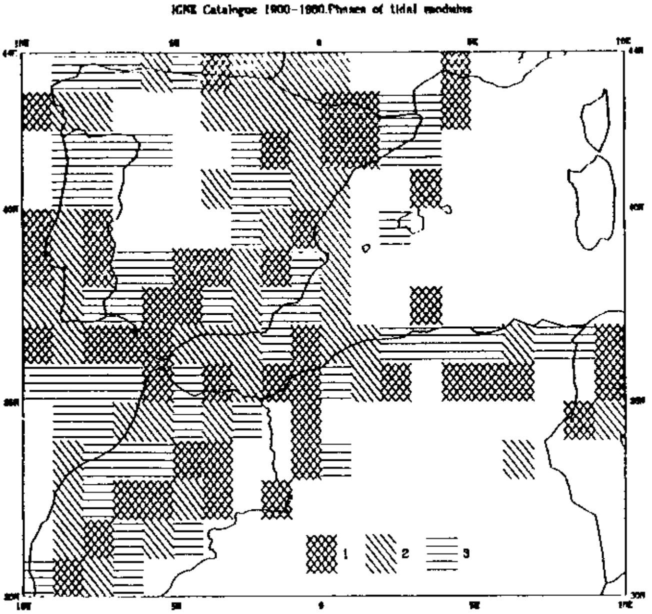

Figure 5. The map of the state of general stress: 1) compression, 2) tension, 3) neutral.

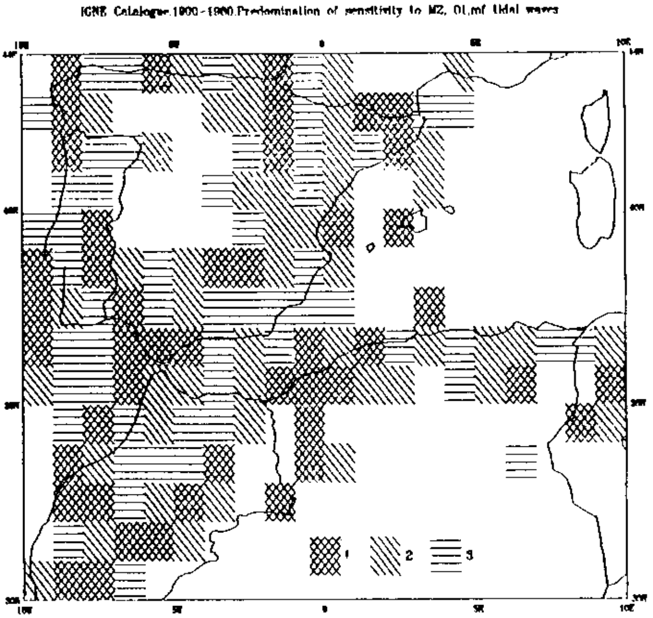

Figure 6. The map of dominant tensosensitivity for separate tidal waves: 1) main semi-diurnal(M2), 2) main diurnal(01), 3) fortnightly (mf).

The region of the Ibero-Maghrebian limited by 30-44N and 10W—10E was separated into windows of 1 × 1 degrees. The IGNE Catalogue of earthquakes with M>3, which occured during 1900-1980 was used to study the tidal triggering effect. The total number of shocks is more than 7 thousands[3].

Fig. 1 shows, for example, the distribution of N and N values for phases of W-E component of the tidal vector. Two numbers are shown in each window. The upper one, N_+ corresponds to the earthquakes that happend during phase of compression, and the lower one, N_-, during the phase of tension of the W-E component of the tidal vector. The highest value of the normalized differences coefficient, $t=(N_+-N_-)/2\delta$, is equal -2.5 (Southern Pyrenean Zone). Figs. 2, 3, 4, 5 show the distribution of compression (double dashed lines, $t>+0.5$), tension (slanting lines, $t<-0.5$) and neutral (horizontal lines, $-0.5<t<+0.5$) areas for W-E, N-S, vertical component and whole tidal stress vector.

Fig. 6 shows the domination of earthquake sensitivity to the phases of three separate waves: Main Semi-Diurnal (M2), Diurnal (01) and fortnightly (mf). This last map shows that different areas have different sensitivity to the main harmonics of earth's tide.

This technique may be applied for the much more detailed study using data on weak shocks as well as on seismic and acoustic emission observed on the earth surface and in the boreholes.

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