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ON THE PREDICTION OF EARTHQUAKES BASED ON SOME GEOMAGNETIC OBSERVATIONS IN SOFIA- SKOPJE REGION

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Abstract: *The statistic evidences that the geomagnetic "quakes" are reliable earthquake precursor based on one year Sofia (1 component) and Skopje (3 component) geomagnetic monitoring are presented. Additionally a new accurate systematic of earthquakes based on parameters magnitude, intensity, depth, radius (volume) and rigidity is proposed. Some results of the performed processing of the catalogues of the stronger Balkan earthquakes are demonstrated*.

The short-term prediction of the time, epicentre and magnitude of the earthquakes is not a solved problem [1-4]. One of the used prospective approaches in this matter is based on the connection between earthquakes, tidal behavior and the electromagnetic phenomena over the Earth surface [5-8]. In the last two papers some preliminary successful earthquake prediction results are reported for the Sofia region on the base of the geomagnetic monitoring and software package created in INRNE of BAS for possible correlation between electromagnetic earth fields and future earthquakes. The role of geomagnetic variations as precursor can be explained by the hypothesis that in the time of earthquakes preparing, with grows of strain, deformation or displacement in the Earth depth in some interval of density changing, arises the chemical phase shift which leads to an electrical charge shift . Sstatistically proved evidences that the geomagnetic quake is a reliable imminent earthquake precursor are published in [8]. In the present paper we presented some unpublished information and comments about the supervened investigated period in Central Balkan region. Additionally some new systematic of earthquakes based on parameters magnitude, intensity, depth, radius (volume) and rigidity is proposed and some preliminary results of the processing of the catalogues of the stronger Balkan and World earthquakes are demonstrated. More detailed information about our efforts to research the possibility of short term earthquake prediction on the basis of electromagnetic field variations beneath, on or over the Earth surface and near Space could be find in the web site http://theo.inrne.bas.bg/~mavrodi [9]. Every day Sofia (one component) and Skopje (vector variometer mode) geomagnetic and earthquake monitoring, the same monthly monitoring and assessment of the prediction reliability are presented together with some links, collaborations and projects which aim is to create a working system for research the possibilities of short term prediction of the earthquakes in the Balkan region. Of course, such complex problem as the prediction of time, place and magnitude of the incoming earthquake can be solved only in the framework of wide interdisciplinary scientific group which includes many branches of the Earth System Sciences and some methods from modern high energy particle and solid states physics, nonlinear problems mathematics etc.

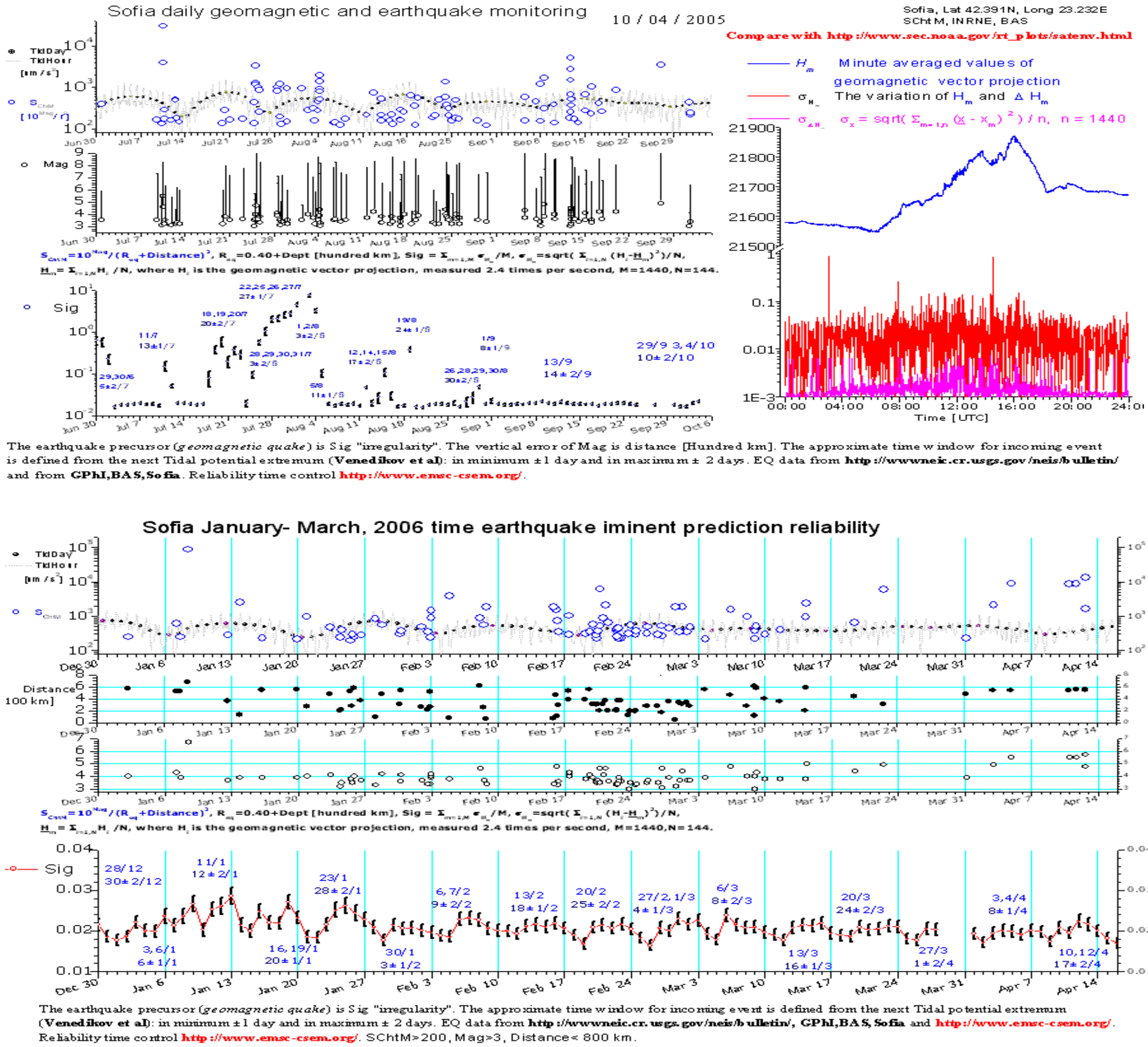


Fig. 1. Geomagnetic and earthquake monitoring in Sofia for 2005 and 2006

As it was discussed before [8] the performed analysis of the correlations between the behavior of the geomagnetic field, Earth tidal gravitational potential [10] and the occurred earthquakes allow us to established that the daily averaged value of σ_{H_m} and $\sigma_{\Delta H_m}$, which we denote by Sig (ΔSig) [8], is playing the role of earthquake precursor. Statistically proved evidences that the geomagnetic quake is a reliable imminent earthquake precursor were published in [8] for the Sofia one component geomagnetic monitoring from August 2001 until March 2005 and for the Skopje three component geomagnetic monitoring from July 2004 until March 2005. Here after some example for the next one year period of investigations is presented – Figures 1, 2. Most concrete and detailed analyses of the results are published in [9]. From the correlations between the geomagnetic quakes shown on the Figures 1, 2 and the time sequences of the occurred earthquakes it could be seen that the geomagnetic quakes are precursors for incoming earthquake activities somewhere in the region during the next minimum or maximum of the local Tidal gravitational potential.

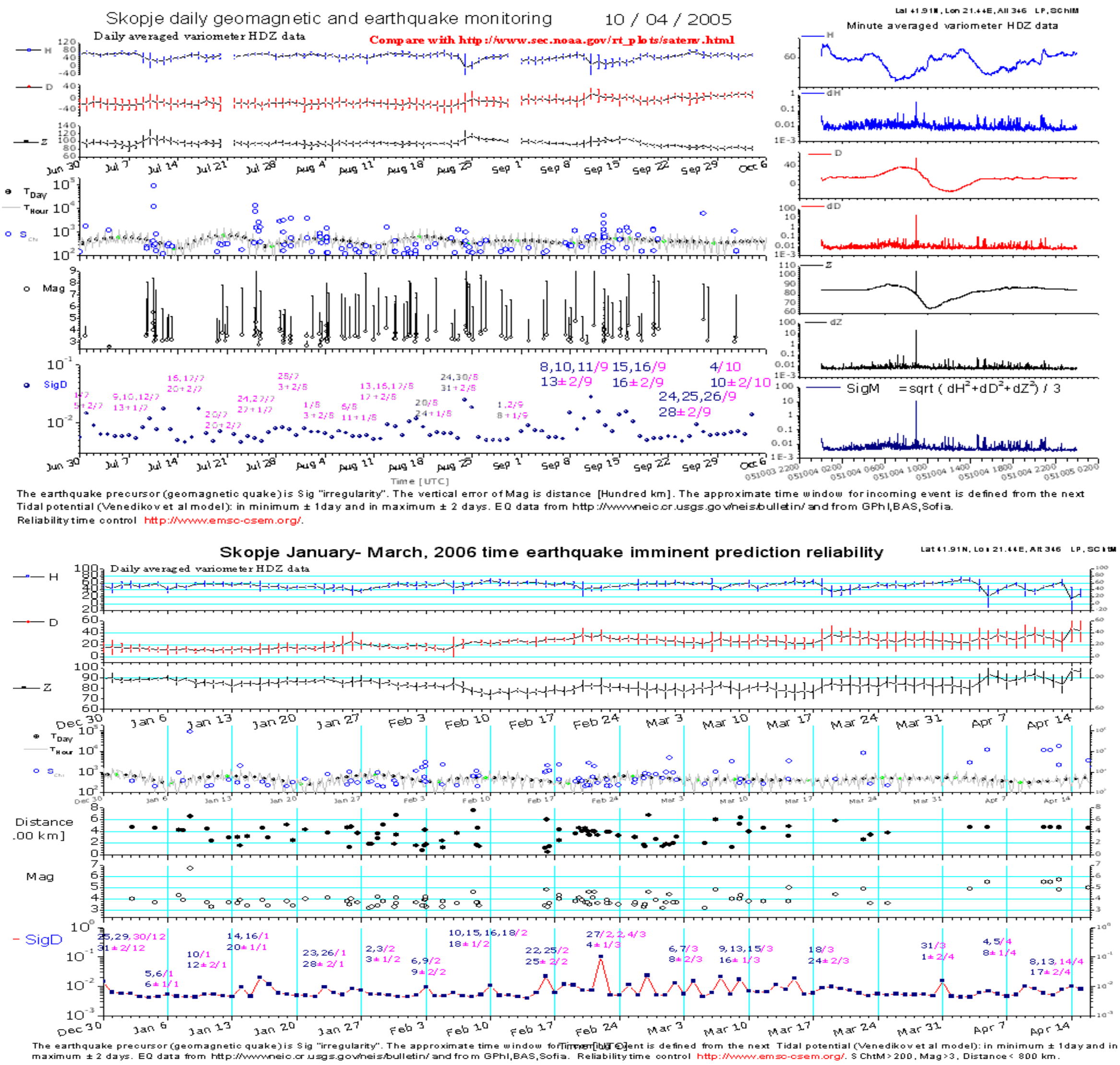


Fig. 2. Geomagnetic and earthquake monitoring in Skopje for 2005 – 2006

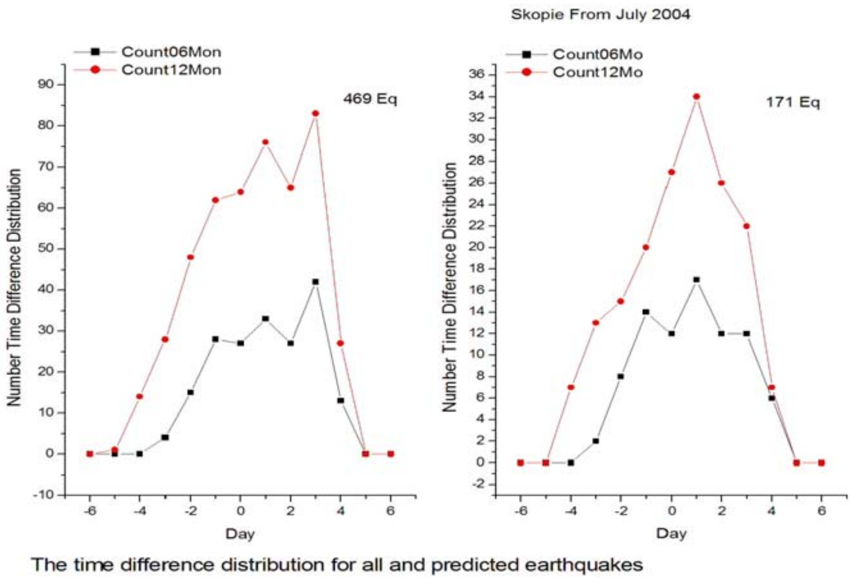


Fig. 3. Reliability test of the and Skopje data for 2005- 2006: Time difference distributions of predicted and all occurred earthquakes

In Figure 3 the distributions of the differences between the times of predicted and occurred events, calculated at different month's periods (6 or 12 months) for 2005 - 2006 are presented. The growth of the distribution without widening and its approximation the Gauss distribution in time is argument that the correlation geomagnetic signal- Tidal potential extremum and occurred earthquake has a physical causality source. The number of earthquakes, analyzed in Figure 3 is greater than the predictions of the events. The obvious reason is that in the case of some earthquakes with greater Magnitude there are aftershocks.

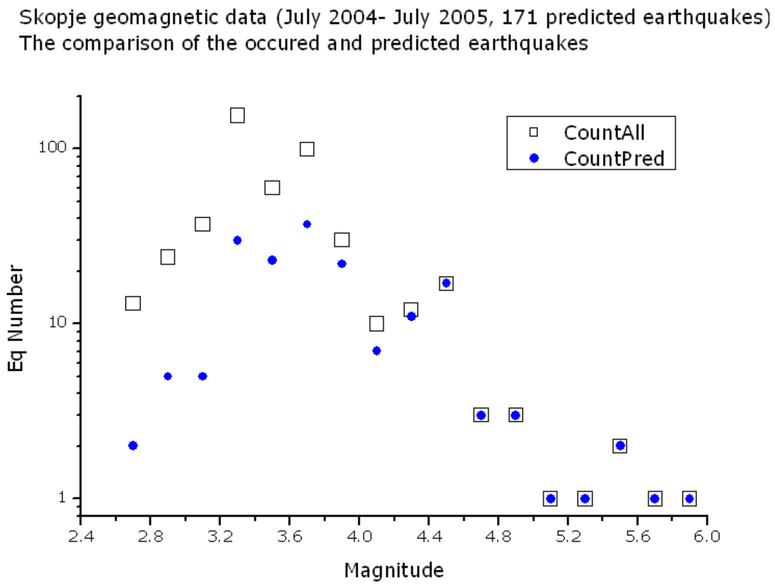


Fig. 4. Reliability test of the Skopje data: Numbers of all and predicted earthquakes

The comparison between the number of all occurred earthquakes and the number of predicted only events according to Skopje geomagnetic data (Fig.4) shows that almost all events with magnitude M>4.5 are predicted. With another words we can say that the geomagnetic quake can stay as an earthquake precursor for earthquakes around the Skopje region only for the events with Magnitude most probably more then M= 4.5, Almost the same result was obtained for the Sofia region (see for example [8]).

Additionally a new accurate systematic of earthquakes based on parameters magnitude, intensity, depth (h), radius (volume) and rigidity.

$$Energy = Volume\ \mathrm{Rigidity}(h)^3 ,$$

where the Volume is

$$Volume = \frac{4}{3}\pi\, Req^3 ,$$

Rigidity with dimension cubic root of energy, devoted to volume, which is the energy density in one direction (line)

$$\mathrm{Rigidity}(h) = \frac{a_1 \left(h + e^{(-a_3 h)}\right)^3}{e^{\left(a_2\left(h + e^{(-a_3 h)}\right)\right)} - 1} ,$$

and **Req=0.35 * beta / fo**, "beta" is the velocity of the shear seismic waves and "fo" is the corner frequency of the displacement amplitude spectrum in the far field.

The magnitude parameterization has a form

$$MagnitudeTh = \frac{\mathrm{Log}\left(\frac{4}{3}\pi\, Req^3\, \mathrm{Rigidity}(h)^3\right) - a_7}{a_6},$$

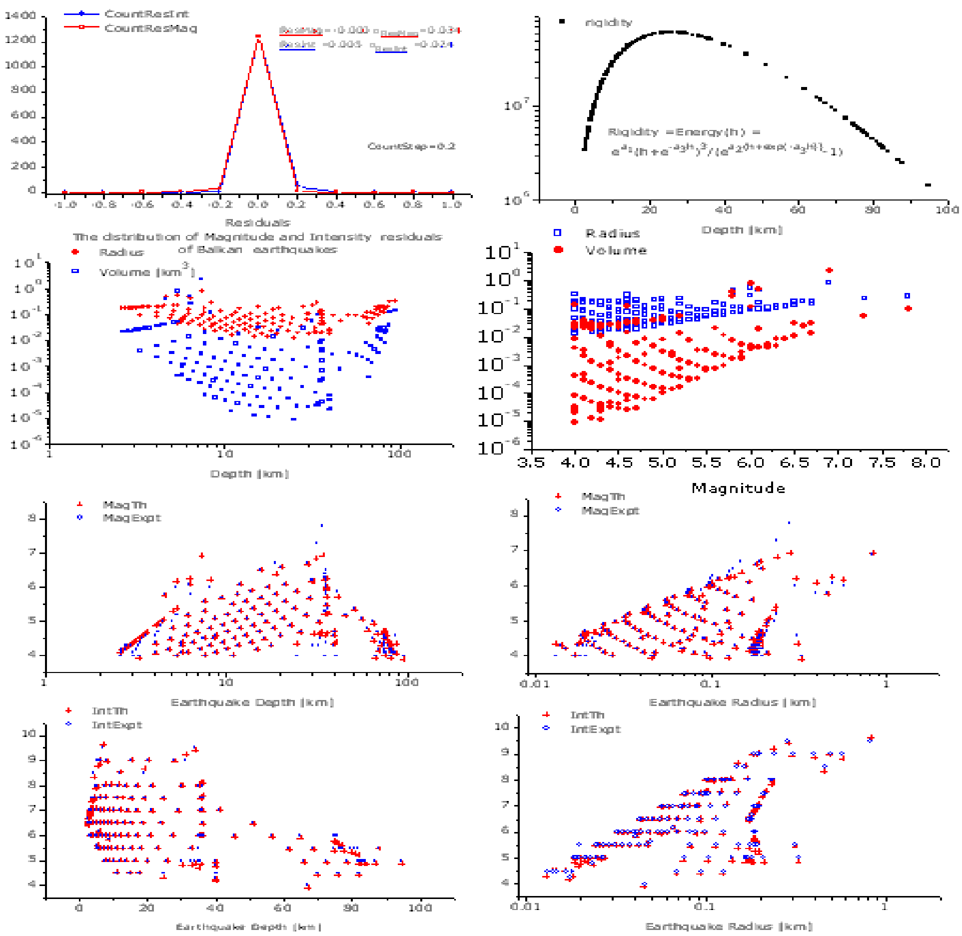
where in agreement with the Richter formulae the earthquake energy is:

$$Energy = 10^{(a_7 + a_6\, MagnitudeTh)}.$$

The intensity parameterization has a form

$$IntensiyTh = e^{\left(\frac{a_4\, Req}{h + e^{(-a_3 h)} + Req}\right) MagnitudeTh} + e^{(-a_5)}\, \mathrm{Log}\left(\frac{Energy}{\left(h + e^{(-a_3 h)} + Req\right)^2\, \mathrm{Rigidity}(h)^2}\right)$$

Some results of the performed processing of the catalogues of the stronger Balkan earthquakes are demonstrated bellow:



The graphical ilustration of Magnitude, Intensity, Depth, Radius and Rigidity systematic for Balkan 1296 earthquakes (1901-1996)

Fig. 5. Graphical illustration of magnitude, intensity, depth (h), radius (volume) and rigidity systematic for stronger Balkan earthquakes (1901 – 1996).

The analytical dependence of rigidity on the depth is the same as of the Planck's law of black body radiation dependence on frequency. Thus, rigidity can be interpreted as quantum mechanical estimation of the matter phase shift energy in the time of earthquake preparation (when electromagnetic and other precursors appear) as well as during its occurrence.

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