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GEOMAGNETIC-QUAKE AS IMMINENT RELIABLE EARTHQUAKE PRECURSOR BASED ON SKOPJE, SOFIA, KIEV AND LVOV GEOMAGNETIC AND EARTHQUAKE MONITORING - STARTING POINT FOR COMPLEX BALKAN BLACK SEA NETWORK

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Abstract: *The imminent regional "when" earthquake's predictions are based on the correlation between observed geomagnetic-quakes and the incoming minimum/maximum of tidal gravitational potential. The geomagnetic-quake is defined as an abrupt change of day- mean value of geomagnetic field one minute standard. The probability time window for the incoming earthquake or earthquakes is approximately ± 1 day for the tidal minimum and for the maximum- ± 2 days. The statistic evidence for reliability of the geomagnetic precursor is based on the distributions of the time difference between occurred and predicted earthquakes for Sofia, Skopje region which lean to the Gaussian behavior with increasing of the statistic.. The predicted earthquake is identified by the maximum of the function proportional to the density of the earthquake radiated energy in the monitoring point. The analytical size of this function as well as one minute time scale for calculating the geomagnetic-quake signal was established by Sofia- Dubna inverse problem method. The preliminary analysis of Kiev and Lvov data are presented. The project for complex Balkan- Black Sea NETWORK for earthquake researching and prediction is shortly described.*

Introduction

The problem of "when, where and how" earthquake prediction can not be solved only on the basis of seismic and geodetic data (Aki, 1995; Pakiser and Shedlock, 1995; Geller et al., 1997, Main, 1999a, b; Ludwin, 2001).

The possible tidal triggering of the earthquakes has been investigated for a long period of time (Knopoff, 1964; Tamrazyan, 1967; 1968; Ryabl at al., 1968; Shlien, 1972; Molher, 1980; Sounau et al., 1982; Burton, 1986; Shirley, 1988; Bragin, 1999).

The including of additional information in the precursors monitoring, for example, the analysis of under, on and above Erath surface electromagnetic field variations can define reliable earthquake precursor and to estimate the most probable time of incoming earthquake. See for example some results and analysis in papers: Hayakawa et all,1999, Eftaxias, 2001; Hayakawa, Molchanov, 2002; Varotsos et all, 2002, 2003; Dudkin et al, 2003; Telesca et all, 2004.

In the papers (Mavrodiev, Thanassoulas, 2001; Mavrodiev, 2002 a, b, 2003 a, b, c; Mavrodiev, 2004) was presented some progress for establishing the geomagnetic filed variations as regional earthquake precursor. The approach is based on the understanding that earthquake processes have a complex origin. Without creating of adequate physical model of the Earth existence, the gravitational and electromagnetic interactions, which ensure the stability of the Sun system and its planets for a long time, the earthquake prediction problem can not be solved in reliable way. The earthquake part of the model have to be repeated in the infinity way "theory- experiment- theory" using nonlinear inverse problem methods looking for the correlations between fields in dynamically changed space and time scales. Of course, every approximate model (see for example Varotsos, 1984, a, b, Varotsos et al, 2006; Thanassoulas, 1991; Thanassoulas et al., 2001a, b; Eftaxias at all, 2006, Duma, 2006) which has some experimental evidence has to be included in the analysis. The adequate physical understanding of the correlations between electromagnetic precursors, tidal extremums and incoming earthquake is connected with the progress of the adequate Earth's magnetism theory as well as the quantum mechanical understanding of the processes in the earthquake source volume before and in the time of earthquake.

The achievement of the Earth's surface tidal potential modeling, which includes the ocean and atmosphere tidal influences, is an essential part of the research. In this sense the comparison of the Earth tides analysis programs (Dierks and Neumeyer, ws) for the ANALYZE from the ETERNA-package, version 3.30 (Wenzel, 1996 a, b), program BAYTAP-G in the version from 15.11.1999 (Tamura, 1991), Program VAV (version from April 2002) of Venedikov et al, 2001, 2003 is very useful.

The role of geomagnetic variations as precursor can be explained by the hypothesis that during the time before the earthquakes, with the strain, deformation or displacement changes in the crust there arise in some interval of density changing the chemical phase shift which leads to an electrical charge shift. The preliminary Fourier analysis of geomagnetic field gives the time period of alteration in minute scale. Such specific geomagnetic variation we call geomagnetic quake. The last years results from laboratory modelling of earthquake processes in increasing stress condition at least qualitatively support the quantum mechanic phase shift explanation for mechanism generating the electromagnetic effects before earthquake and others electromagnetic phenomena in the time of earthquake (Freund et al, 2002; St-Laurent et al, 2006, Vallianatos et all, 2003, 2006)

The future epicentre coordinates have to be estimated from at least 3 points of measuring the geomagnetic vector, using the inverse problem methods, applied for the estimation the coordinates of the volume, where the phase shift arrived in the framework of its time window. For example the first work hypothesis can be that the main part of geomagnetic quake is generated from the vertical Earth Surface-Ionosphere electrical current. Sea also the results of papers (Vallianatos, Tzanis, 2003 ; Duma, Ruzhin, 2003, Duma, 2006) and citations there.

In paper (Mavrodiev, 2004) the geomagnetic quake was defined as a jump of day mean value of signal function Sig. The geomagnetic vector projection H_i is measured with relative accuracy less or equal to 1 nT by a fluxgate, feedback based device of rather original and simple, but powerful construction. (know-how of JINR, Dubna, Boris Vasiliev, 1998, private communication). It is used with 2.4 samples per second. Due to technical reasons the sensor was oriented under the Horizon in a manner that the measured value of H_i is less than 20 000 nT.

The predicted earthquake is identified by the maximum of the function S_{ChtM} proportional to the density of the earthquake radiated energy in the monitoring point. Thus, if we have a jump of signal function Sig and its error Sig is such that satisfy numerically some conditions(Mavrodiev, 2004) in the next tidal extremum time the function S_{ChtM} will has a local maximum value. The earthquake for which the function S_{ChtM} has a maximum can be interpreted as predicted earthquake.The analytical size of the function S_{ChtM} as well as one minute time period for calculating the unique signal for geomagnetic quake which is reliable earthquake precursor was established by Dubna inverse problem method (Dubna Papers). One could say that this method is algorithmization of "probe- error" researching of hidden dependences for some time or space series of experimental data.

Eq data

There was analyzed earthquakes data in region with latitude (37^0, 41^0) and longitude (15^0, 31^0) for 2006, reported in USGS, NEIC: earthquake search results, Catalog- PDE, magnitude range from 3.0 to 9.0, data selection- historical & preliminary data- 705 earthquakes. There are reported 2007 data for 705 earthquakes because IRIS catalogue contains all types of measured for one earthquake magnitudes.

The next Figures 1, 2, 3 illustrate the distributions of earthquake's magnitudes, depth and the difference between tidal extremum date and time of occurred earthquakes with magnitude grater then 3.

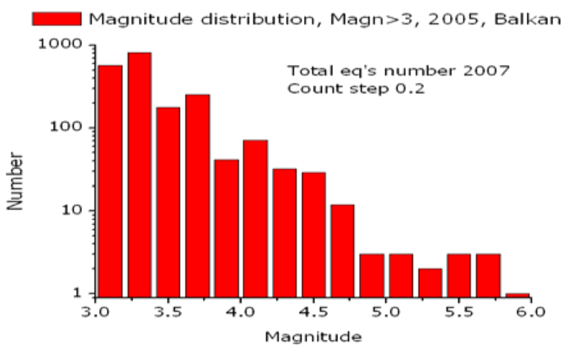


Fig.1. *The magnitude distribution*

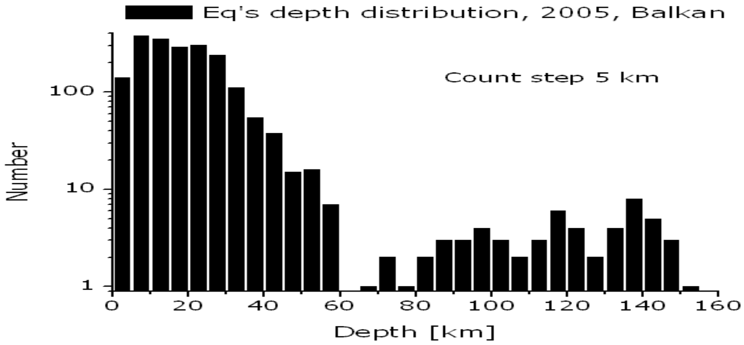


***Fig.2**. The earthquake's depth distribution*

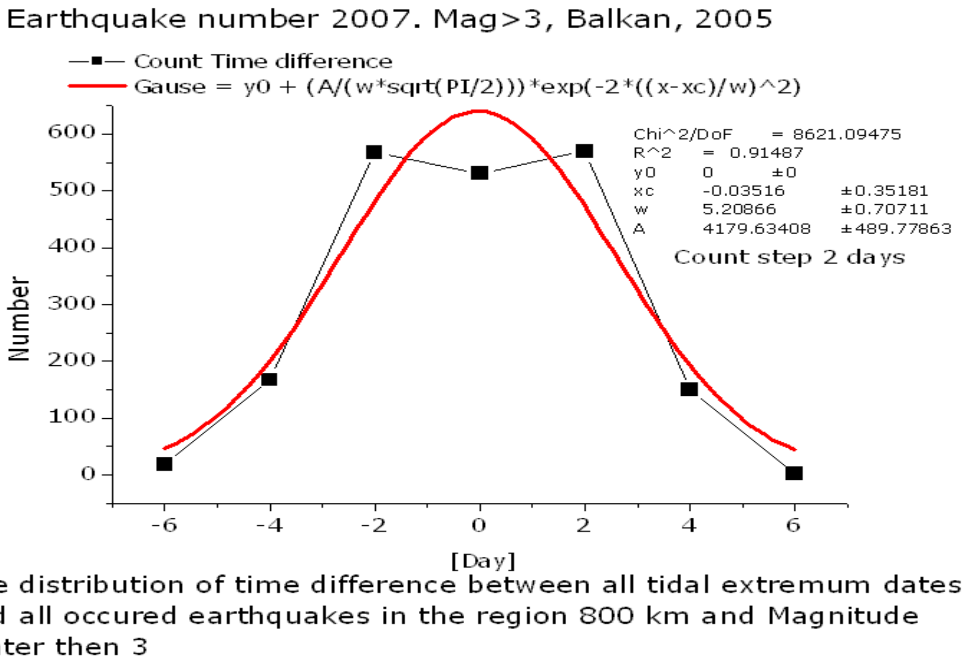


Fig. 3.

Analysis

The next Fig.4. present the distribution of the difference between predicted tidal extremum data and the date of occurred earthquakes in the region identified as predicted from the condition for local time maximum of function SChtM:

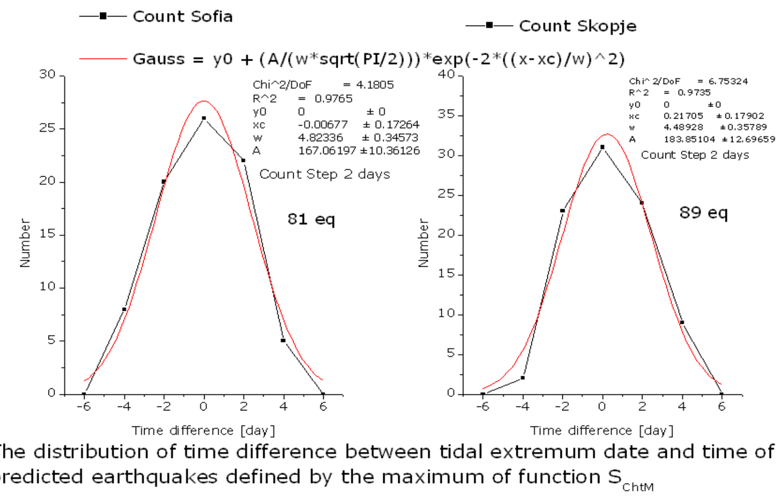
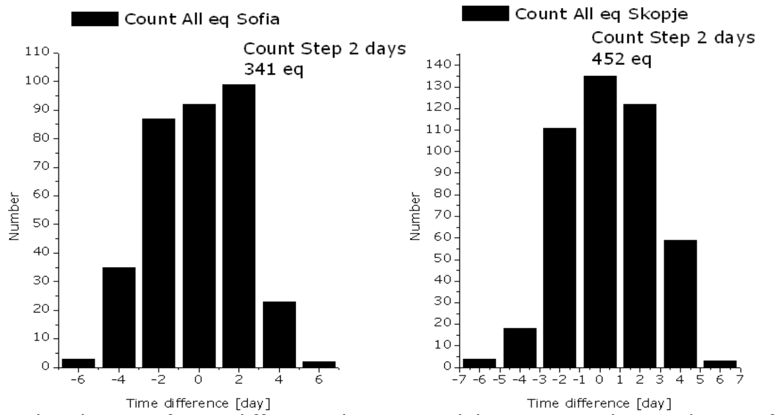


Fig.4.

The comparison of time distributions presented in Fig.3 for all occurred in the region earthquakes and in Fig. 4. for Skopje and Sofia as well as its Chi^2 and wide is in support the geomagnetic quake is reliable time precursor for impending earthquake or earthquakes in the region.

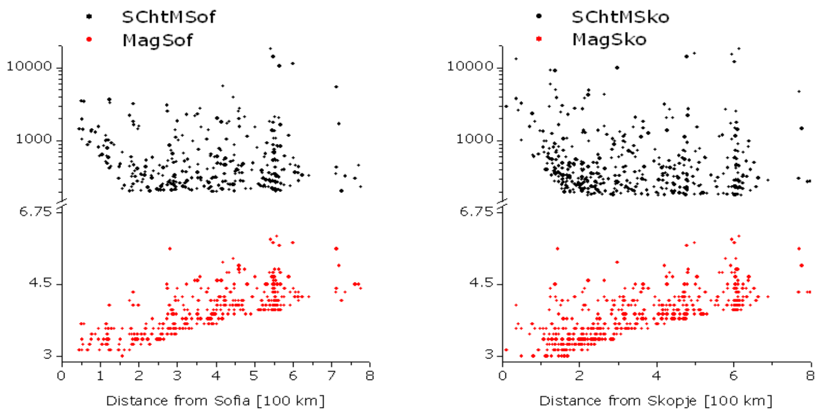
The next Fig.5. present the time distribution for all occurred earthquakes in the region earthquake with conditions S_{ChtM}>200 and magnitude >3.



The distribution of time difference between tidal extremum date and time of all occured in the region earthquakes defined by S_{ChtM} >200

Fig.5.

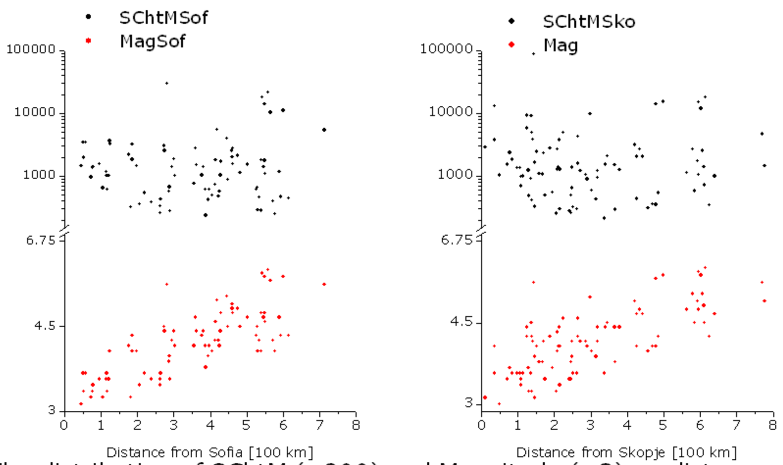
The next Fig.6. present the SChtM and magnitude distribution for all occurred in the region earthquake as function of distance from the monitoring point with SChtM>200 andM >3.



The distribution of SChtM (>200) and Magnitude (>3) on distances for all occured earthquakes in the region

Fig.6.

The comparison of the distributions in Fig.6. and Fig.7. can give some presentation for distance and magnitude sensibility of the geomagnetic approach.



The distribution of SChtM (>200) and Magnitude (>3) on distances for predicted earthquakes

Fig.7.

One have to stress that the solving the problem of distance and magnitude sensibility of the geomagnetic approach using the inverse methods can be performed uniquely on the basis of at least triangle (100- 200 km) stationary geomagnetic monitoring set plus one mobile.

The next Fig.8. present the comparison of the numbers of all and predicted earthquakes for Sofia and Skopje. It is seen that all occurred earthquakes with magnitude grater then 5 was predicted.

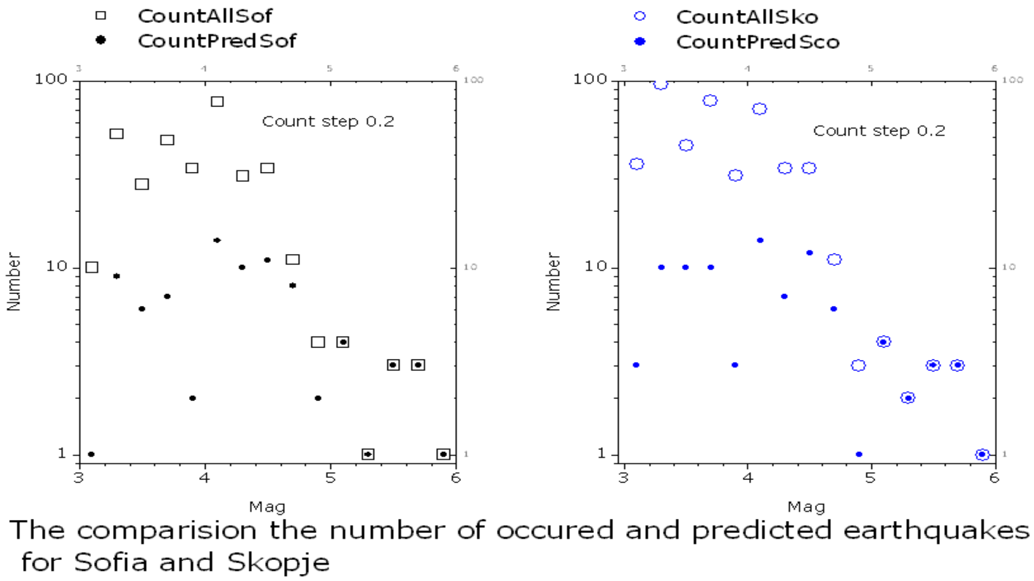


Fig.8.

The next Fig.9. present the map graphic for earthquakes with magnitude grater then 5 predicted simultaneously from Skopje and Sofia measurements.

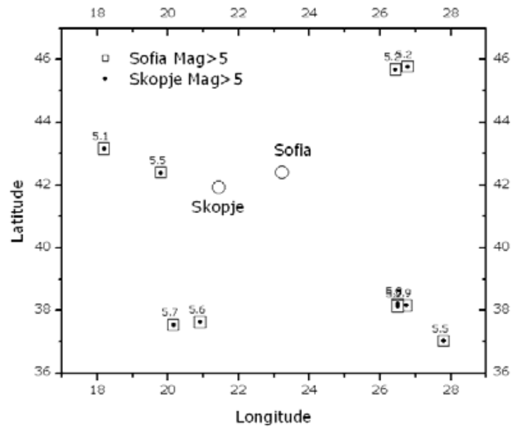


Fig.9.

The confirmation of one geomagnetic component Sofia data from the vector Skopje results for reliability time window earthquake prediction can be consider as a first step for solution of “when, where and how” earthquake prediction at level “when”. It is obvious that the occurred in the predicted time period earthquake with maximum value of function SChtM (proportional to the Richter energy density in the monitoring point) is the predicted earthquake. But some times there are more then one geomagnetic signals in one day or some in different days. It is not possible to perform unique interpretation and to choose the predicted earthquakes between some of them with less values of energy density. The solution of this problem can be given by the analysis of the vector geomagnetic monitoring data in at least 3 points, which will permit to start solving the inverse problem for estimation the coordinates of geomagnetic quake source as function of geomagnetic quake. The numbering of powers of freedom for estimation the epicenter, depth, magnitude and intensity (maximum values of accelerator vector and its dangerous frequencies) and the number of possible earthquake precursors show that the nonlinear system of inverse problem will be overdeterminated.

Thus, the first prove, that in the framework of such complex approach, the “when, where and how” earthquake prediction problem can be solve will be the “when, where” prediction on the basis of at least 3 points for electromagnetic real time monitoring is essential. If the statistic estimation will be successful for a long enough period of time (6-12 months) and the established correlations are confirmed by the adequate physical model solutions, one could say that the earthquake prediction problem is under solving using the electromagnetic quake precursor.

Experimentally, the first attempts for estimation of the future epicenter can be performed on the basis of isolines distribution of geomagnetic quake and electropotential data set as well as by using the VAN and radio data. Theoretically, the simplest model for starting to solve the inverse problem is to estimate the coordinates of vertical Earth surface – Ionosphere electrical current which is generated by the geomagnetic quake. Such type of modeling has to be performed step by step by including the volume of solid state phase shifts and frequency characteristics like function of stress, depth and geology.

The posteriori analysis for England, Alaska, India, Kamchatka, Hokkaido regions on the basis of second vector Intermagnet data [INTERMAGNET, WS], also confirm the reliability of geomagnetic quake as imminent earthquake precursors (Mavrodiev 2003 a, b, 2004).

Conclusions: The correlations between the local geomagnetic quake and incoming earthquakes, which occur in the time window defined from tidal minimum (± 1 day) or maximum (± 2 days) of the Earth tidal gravitational potential are tested statistically. The distribution of the time difference between predicted and occurred events is going to be Gaussian with the increasing of the statistics.

This result can be interpreted as first reliable approach for solving the “when” earthquakes prediction problem using the geomagnetic data.

The project for complex regional NETWORK for earthquake prediction by using the reliable precursors will be proposed in near future. The Project is based on the temporary data acquisition system for preliminary archiving, testing, visualizing and analyzing the data with aim to prepare regional daily risk estimations.

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