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OBSERVATION OF GEOMAGNETIC FIELD DISTURBANCES DURING EARTHQUAKES

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Abstract: *During some moderate (with magnitude values more than 3) Balkan earthquakes, the three geomagnetic field (GMF) components Bx, By, Bz variations were investigated and small value disturbances (up or down jumps) were observed. With respect to these disturbances it was found out that, in approximately 70% of the earthquake events, there are no coincidences between the times of Bz and the other two geomagnetic field components. This fact shows that the disturbances in the Bz component are not caused by EM induction in the ambient geo-space environment caused by the currents' systems. Thus, the Bz disturbances in these cases can be associated with the changes of the solid earth conditions and subsurface currents which exist during most of the observed earthquakes. The investigated time period is three years (2006–2008) and the geomagnetic field variations during a number of earthquake events on the Central Balkan territory were observed.*

НАБЛЮДЕНИЯ НА ГЕОМАГНИТНОТО ПОЛЕ ПО ВРЕМЕ НА ЗЕМЕТРЕСЕНИЯ

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Резюме: *По време на умерени земетресения на Балканите (с магнитуд над 3) са изследвани вариациите на трите компоненти на геомагнитното поле (Bx, By, Bz), като са наблюдавани слаби смущения (скокове "нагоре" и "надолу" на магнитограмите). За тези смущения беше установено, че в около 70% от случаите на земетресения няма съвпадение във времето на скоковете на Bz компонентата и такива на другите две компоненти. Това показва, че смущението на Bz в тези случаи, не е предизвикано от електромагнитна индукция в твърдата земя от йоносферните и магнитосферните токови системи. Така тези смущенията на Bz магат да се асоциират с промени на условията в твърдата земя и с телуричните токове, които съществуват по време на повечето земетресения.Наблюдавания период е три години (2006–2008 г.), като през него са изследвани вариациите на геомагнитното поле по време на редица земетресения на територията Централните балкани .*

In the present investigation some changes of the three components of the geomagnetic field (GMF) recorded in the Panagyurishte Geomagnetic Observatory (PAG) (70 km east south of Sofia city) during the time of moderate strong earthquakes (with magnitude M > 3.0) are examined. The parameters of the earthquakes are determined by Bulgarian National Seismological Network managed by National Institute for Geophysics, Geodesy and Geography of Bulgarian Academy of Sciences (Fig.1). The earthquake epicenters are located in the area surrounding the observatory at distances from 50 to 300 km (Fig.2) and they are events from the period 2006 – 2008. For the analyses of the elements of the

Fig.1. Seismic stations used for determination of the parameters of the earthquakes

Fig. 2. Locations of the epicenters of earthquakes and geomagnetic observatory

geomagnetic field average minute values from the variometers of the observatory are used, which register values in seconds with accuracy of 0.1nT. By determining the average minute values via values in seconds, that value is not a margin of accuracy and registration of the changes of the field from a couple of tenths from the nT unit in average minute value could be accepted as actually registered changes of the field in the range of one minute. That is why because the actual values of the variation in the range of couple or sometimes couple of tenths nT furthermore couple of times in

the limit of that minute are reflected in the average minute values as changes in the range of couple of tenths of one nT.
In the earth crust a definite distribution of electric conductivity exists. As a result of induction, provoked by the ionosphere and magnetosphere current systems, so called telluric currents started to flow in the earth medium. In calm days (in geomagnetic respect) these currents contribute to the one twenty-four hour variation of the vertical component, and the variation of the north and east component are a result from the already mentioned primary currents in the ionosphere – magnetosphere systems.
In general case the components of the geo-electric and geo-magnetic field for anisotropic medium are connected with the magneto-telluric tensor, but if only is observed the connection between the components of the magnetic field, then it is simpler and the corresponding expression is given by means of the component *Bx*, *By* and *Bz* of the geomagnetic field, and the components of the well-known in the geomagnetism typer "vector" or "magnetic arrow" [1].
For points of registration of the variations of the geomagnetic field, located on the earth surface, the change of *Bz* under non-changing *Bx* and *By* means that in Earth under these points is changed the typer "vector" by reasons, which could searched only in change of the physical conditions in the Earth. This means that if at the time of nearly located seismic events are not observed substantial changes of *Bx* and *By*, but these are observed for *Bz*, it could be assumed eventual influence of the changing condition in the Earth, which lead ultimately to change in electrical conductivity. For explanation of the nature of such changes of the electric conductivity there are a couple of possibilities. One of them is by change of the rock pressure under the registration point to obtain local changes of the electrical conductivity of the rock types. Second possibility is changes of electrical conductivity as a result of the movement of conductive fluid (electrolyte, created in rock cracks by water and ions with different chemical elements, dissolved in it). Regardless of the physical mechanism of the eventually arising changes of the electrical conductivity under change of the rock pressure at the time of the seismic event - the main relation between the various components remains unchanged.
In the present work a research is made on the presence or the absence of correlation of the variations of the vertical component and horizontal components of the geomagnetic field with the purpose change to be established of the typer "vector" for concrete seismic events. In the period 2006 – 2008 are observed changes in the components of the geomagnetic field in the geomagnetic PAG Observatory for 12 earthquakes, which are presented with their parameters in Table 1. The table shows the time of the seismic event and the coordinates of the epicenters. In the sixth colon the observed changes in *Bz* component are described. In the next colon the changes in *Bx* component are described and in the eight colon the connection between these two components at the time of seismic events is assessed. In the same way in colons 9 and 10 the results from the observation of *By* component are presented and its connection with *Bz* is assessed.

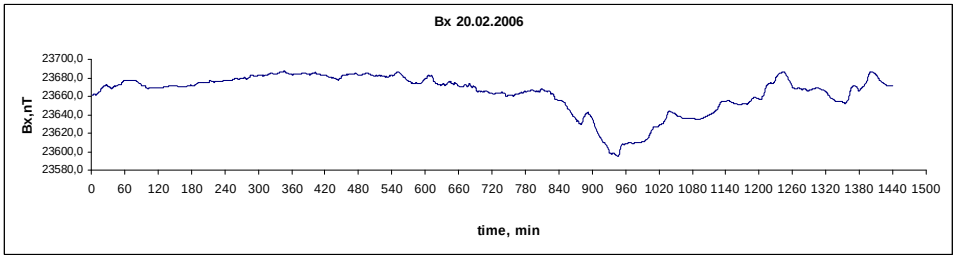

Fig. 3. Bx component registered in PAG observatory - 20.02.2006

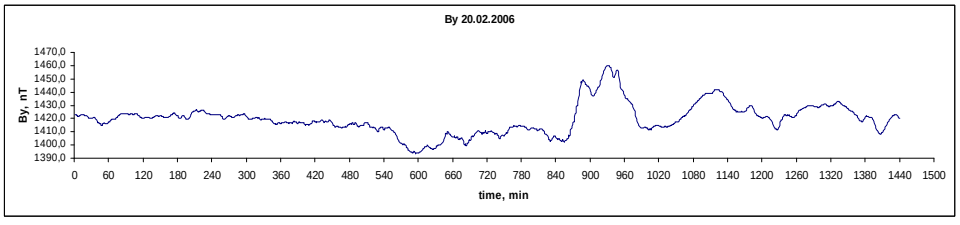

Fig. 4 . By component registered in PAG observatory - 20.02.2006

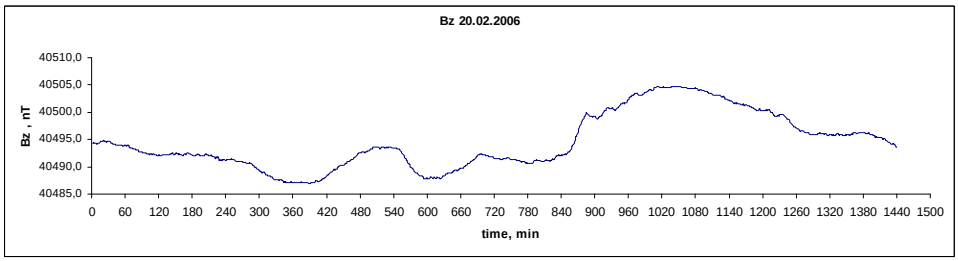

Fig. 5. Bz component registered in PAG observatory - 20.02.2006

For illustration on the Figures 3, 4 and 5 magnetograms of the three components of geomagnetic field are showed for one of the cases from Table 1 - the earthquake dated 20.02.2006. From these magnetograms could be seen that at 05.20 p.m. (1040 minute of the twenty-four hour day in which the earthquake took place) is registered sharp leap of *Bz* as the other two components did not go under that sharp change.

Table 1. Earthquake parameters and coincidence at the time between Bz and Bx , By geomagnetic field component jumps registered in PAG observatory during 2006, 2007 and 2008

№	**Earthquake date,** Y, M, D	**Time,** UT	**Earthquake coordinates,** deg **; Distance from PAG,** km	**Magnitude**	**Geomagnetic field component Bz ,** obtained in time jumps	**Geomagnetic field component Bx ,** obtained most close jumps and "gradients"	**Coincidence at the time** between **Bz** and **Bx** jumps	**Geomagnetic field component By ,** obtained most close jumps and "gradients"	**Coincidence at the time** between **Bz** and **By** jumps
1	2006 01 20	23:09	42.69 26.52;	3.9	Jump up	Before 1 min. start up "gradient"	**no**	Up "gradient" no jump	**no**
2	2006 02 04	21:33	41.87 22.95 ;	3.8	Jump up	After 1 min. small jump up	**no**	Small jump down	**no**
3	2006 02 20	17:20	41.69 25.48 ;	4.5	Jump up	Up "gradient" no jump	**no**	Up "gradient" no jump	**no**
4	2006 05 10	07:29	42.97 22.96 ;	3.9	Small jump up	Before 2 min. small jump down	**no**	Down "gradient" no jump	**no**
5	2007 09 23	00:54	40.70 27.50 ;	5.8	Jump up	Before 4 min small jump up	**no**	Jump up	**yes**
6	2007 08 03	19:32	41.61 23.65 ;	3.4	No jump	----------	----------	----------	----------
7	2007 04 16	07:38	41.50 20.40 ;	4.8	After 1 min. jumps up and down	Before 5 min. jump down	**no**	Down"gradient". After 1 min. jump down.	**no**
8	2008 04 15	03:43	42.90 25.37 ;	4.2	Short small jump up	Before 6 min. two jumps with Up and down parts	**no**	No jump	**no**
9	2008 05 12	10:11	43.25 26.05 ;	4.2	No jump	----------	----------	----------	----------
10	2008 10 07	23:26	41.74 24.03 ;	3.7	After 2 min. jump down	Down "gradient" after 1 min. small jump up	**no**	Down "gradient" Start small flat part	**no**
11	2008 11 05	07:36	43.13 27.48 ;	3.8	After 1 min. small jump up	Jump up	**?**	No jump	**no**
12	2008 11 15	20:08	42.65 23.34 ;	3.7	Short small jump up	Down "gradient" no jump	**no**	Up "gradient" no jump	**no**

The results from the analysis of the data presented in Table 1 as well as an assessment of the possibility for correlation between the changes in behavior of the components of the geomagnetic field for the different events are shown in Table 2. From the last table it is seen that in large per cent from the cases is nor present correlation between the leaps in *Bz* and respectively in *Bx, By* during the

earthquakes. This shows that in these cases it is very likely to be changed the electrical conductivity of the medium under the point of registration and respectively under the effect of the respective seismic event.

Table 2. A probability for correlation between geomagnetic field component jumps and earthquakes with magnitude M>3.0 during 2006, 2007 and 2008

Cases of correlation or no correlation between GMF and earthquakes	Number of cases	Probability for the case realization	Short comments
Absence of Coincidence between Bz and Bx, By components	**8**	**~ 0,67**	No coincidence between Bz and Bx, By components
No jump in Bz	**2**	**~ 0,16**	No correlation between earthquake and GMF
Coincidence only in one component	**1**	**~ 0,08**	Partial coincidence between Bz and Bx, By components
Uncertain case	**1**	**~ 0,08**	No reliability

From the obtained observational results concerning the changes of the components of geomagnetic field during some earthquakes a conclusion could be made that the physical parameters of the medium and in particular the rock electrical conductivity is changed at the time of the seismic event. This lead to disturbances mainly in the vertical component of the field and this is the reason to consider that during seismic events exist electromagnetic phenomena on the adjacent territories. The understanding of these phenomena could be moved forward with considering the actual physical situation in the affected zones. In the first place it is important to be researched how is changed the hyper vector and in the more general case – the magneto-telluric tensor connecting electric and magnetic field inside the Earth under the point of measurement. From the presented results conclusion could be made that it is necessary to be examined the presence of disturbances in the components of the geomagnetic field not in relatively remote region but in the immediate vicinity of the epicenters of earthquakes.

References:

1. P a r k i n s o n, W. D. Introduction to Geomagnetism, Scottish Academic Press, Edinburgh and London, 1983.