International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2019 Vol. 9 (1) January-April, pp. 60-66/Yusupov and Yadigarov
Research Article

REGIONAL VARIATION OF THE GEOMAGNETIC FIELD IN UZBEKISTAN

***Yusupov V.R. and Yadigarov E.M.**
Seismology Institute of Sciences, Academy of the Republic of Uzbekistan, 3, Zulfiyakhonim Str., 100128, Tashkent city, Uzbekistan
**Author for Correspondence*

ABSTRACT
In the article given observed dates of ancient change of the magnetic field on stationary station of Uzbekistan. The ancient changes were compared with magnetic dates of the observatory of the nearby countries. It is shown identically ancient changes on the whole region.

Keywords: *Observatory, Geomagnetic, Anomalies, Seismicity, Earthquakes, Tectonic, Magnetometer*

INTRODUCTION
Earthquakes, volcanic eruptions, fissuring, tectonic movements and other phenomena caused by active processes in the Earth's crust, and in the lithosphere as a whole, bring about not only a formidable loss of human life, but also tremendous material damages.

The geomagnetic field originating in the Earth's core is subject to continuous changes known as secular variation. The change has been known since the 17th century, but it is not uniform over the globe and the rates of change also vary with time. Predictions of future changes are strongly limited due to the fact that the mechanisms causing the field changes are not entirely known. Continuous measurements are necessary to monitor the global secular variation. Time series of secular variation and global models of the geomagnetic field and its evolution with time are used to study the underlying processes in the Earth's core.

The Uzbekistan authorities pay a lot of attention to the research, prediction and prevention of the natural calamities associated with catastrophic processes in the Earth's crust.

The earthquakes on the territory of Uzbekistan are the most frequent and dangerous. It was only in the years 1902-2019 that more than ten violent and destructive earthquakes with M = 5.0-7.4 took place. The research in the area of the contemporary dynamics of the Earth's crust, identification of the phenomena linked to the generation of earthquakes and the physical processes at the earthquake focus, along with elaboration of methods aimed at using the above phenomena in the forecast of the place, time and intensity of earthquakes are a set of the most important tasks facing geophysicists today.

MATERIALS AND METHODS
Comprehensive, systematic and aim-oriented, geological and geophysical investigations of seismic hazards, and the elaboration of scientific background and prediction methods were initiated in Uzbekistan, at the Institute of Seismology of the Academy of Sciences of the Uzbekistan, soon after the destructive earthquake at Tashkent in 1966. Three geodynamical test areas have been established at Tashkent, Fergana and Kyzyl-Kum together with a network of prediction stations where routine observations were organized for a set of seismological, geophysical, hydrogeochemical, geodetical, deformational, deep-reaching and other precursory phenomena of earthquakes. The observations employed proton magnetometers of the following types: MPP-I, PM-OOI, APM, TMP and others.

The fundamental capacity of ferromagnetic to change the magnetic properties due to elastic stresses makes it possible to employ the magnetometric method as one of the primary tools in the measurement of the dynamics of elastic stresses in the Earth's crust. Extensive investigations were not conducted in that area because of the lack of apparatus of adequate accuracy. The technological background for such works in Uzbekistan was provided in the early seventies; since then the use of absolute proton magnetometers having the sensitivity up to 0.1 nT has become widespread. The objective of that research was to derive relationships for the variation of magnetic fields associated with seismotectonic processes in the Earth's crust, and their use for exploration of the focus and elaboration of methods for earthquake prediction.

More than 200 magnetic observatories are presently active all over the world, of which one of third is located in areas with high seismicity, volcanism and intensive tectonics. Therefore the research on changes in the geomagnetic field associated with crustal processes is very effective if it employs the data from the observatories.

The secular change in the geomagnetic field is caused by various processes of internal and external origin, associated with the following features:

1. Processes in the Earth's core;
2. External processes in the Earth's magnetosphere;
3. Changes in the Earth's crust (independent or active, induced or passive).

Slow regional variations incorporate anomalous changes in the magnetic field associated with the processes in the Earth's crust and having typical times of 10-30 years. This variation was investigated by Orlov (1958, 1959), Barsukov, Abdullabekov, Golovkov (1974), Golovkov, Ivanov (1977), Shapiro (1976, 1981, 1983), Rivin (1977, 1980, 1983), Skovorodkin, Bezuglaya (1980), Abdullabekov, Maksudov, 1975, Yanovsky, 1978 and others.

Given observed dates of the ancient change of the magnetic field on ten stationary stations in Uzbekistan. The geomagnetic field changes on time scales from milliseconds to millions of years. Shorter time scales mostly arise from currents in the ionosphere and magnetosphere, and some changes can be traced to geomagnetic storms or daily variations in currents. Changes over time scales of a year or more mostly reflect changes in the Earth's interior, particularly the iron-rich core. These changes are referred to as secular variation.

In order to explore the slow regional variation of the magnetic field of the Earth one analysed the results measured at secular points and the mean yearly data obtained from observatory networks. The drawing indicates that regional properties of the secular behaviour are accompanied by local anomalies in some segments. A closer examination has revealed that the segments with the local anomalies could be attributed to the areas for which the epoch of secular behaviour coincided with the time of seismic activity.

Hence the above property of the secular change is linear. The stretch of the anomalous structure of the secular change coincides with the direction of the primary geological structure. The linear dimension of the identified anomaly is about 300-400 km, its density counted in tens of nanoteslas, and the anomaly has a linear elongated shape.

RESULTS AND DISCUSSION

Magnetic Observatories and IGRF Model

For comparison, we choose magnetic observatories located on the territory of Russia or near its borders, for which average annual values are available up to 2007–2008 (Fig. 1). The average T values obtained at each of the observatories were compared with the values calculated using the IGRF the model in 2005 (after 2005, according to the prediction) at its location. The results obtained for each observatory are shown in Fig. 4 in separate blocks, supplied with the code and the name of the observatory. For clarity, the compared curves are aligned in level, that is, the value of the anomalous field at the location of the observatory was not taken into account. Moreover in Fig. 4 the forecast is given the age-old course of the GMPs module, calculated for 2010, and the latest IGRF model included the whole examining area. Comparison of measured and calculated values shows that for almost all observatories after 2005, the trend of the IGRF secular course has changed. For observatories that fall into the zone of high positive secular variation, while maintaining the main growth trend, the rate of this growth visibly decreased, which is especially noticeable in high latitudes. Minimal deviation can be noted at the booth observatories (BDV) and Panagyurishte (PAG). This result does not depend on the degree of anomaly of the forecast course in the area of the observatory. Thus, the Alma-Ata Observatory (AAA) is located in the most highly anomalous region, and the deviations in the growth rate IGRF for this observatory are comparable to data for the BDV observatory. if we consider the two northern observatories Bear Island (BJN) and Tiksi (TIK), then for the latter the deviation from the forecast is the same, if not higher, than for the BJN observatory, while the level anomalies in the area of the BJN observatory at 120 nTl exceeds the same value for the TIK Observatory. The level of anomalousness of the secular course in the area of the Novosibirsk-Keys Observatory (NVS) is the same as for the TIK Observatory, but there is still steady growth IGRF, and the decrease in speed is comparable to the data for the ARS Observatory. The jump of the IGRF field in 2000, associated with a radical change in the model (changing the order of the polynomial), in the NVS observatory of the same sign as in the PAG observatory, although they are separated from each other by a considerable distance. For closely spaced Nurmiyarvi Observatories (NUR), Borok (BOX), Belsk (BEL) is characterized by a similar deviation from forecast, despite the fact that they are located in zones of different anomalies of the secular course. The Irkutsk Patrony Observatory (IRT) falls into an area where the secular trend forecast for 2010 is close to zero and is about +20 nTl. However, for this observatory after the year 2003 is characterized by a transition to a decrease in the average annual values of the IGRF module, which by 2007 was already 17 ntl. the trend change can be observed for those observatories that fall within the forecast area of negative secular course. This applies to Changchun Observatories (CNH), Beijing (BMT) and the Japanese Mizusawa Observatories (MIZ) and Kakioka. the latter is not shown in fig. 1 since received for its, the results are completely the same as MIZ. The IGRF module in these observatories begins showing an upward trend, albeit in different degree. Unfortunately for the territory of Russia we have no other data to date. But all the examples above have shown that by 2010 the spatial structure of the IGRF have changed and will again be different from the forecast, and now it can affect European part of Russia (Demina and Petrova, 2010) Fig.1.

Variation of T-component of secular change in magnetic field over the section during the years 1964-1969 and 1969-1974. Of the field beyond the present concepts on the sources of the variation inside the Earth and the ionosphere, the secular change in the geomagnetic field was analysed by the data of the world observatories from their beginning until the recent time (Abdullabekov, Golovkov 1974; Abdullabekov, Maksudov 1975; Abdullabekov, Berdaliyev 1976). It is known that the temporal spectrum of the secular change contains phenomena with various typical times:

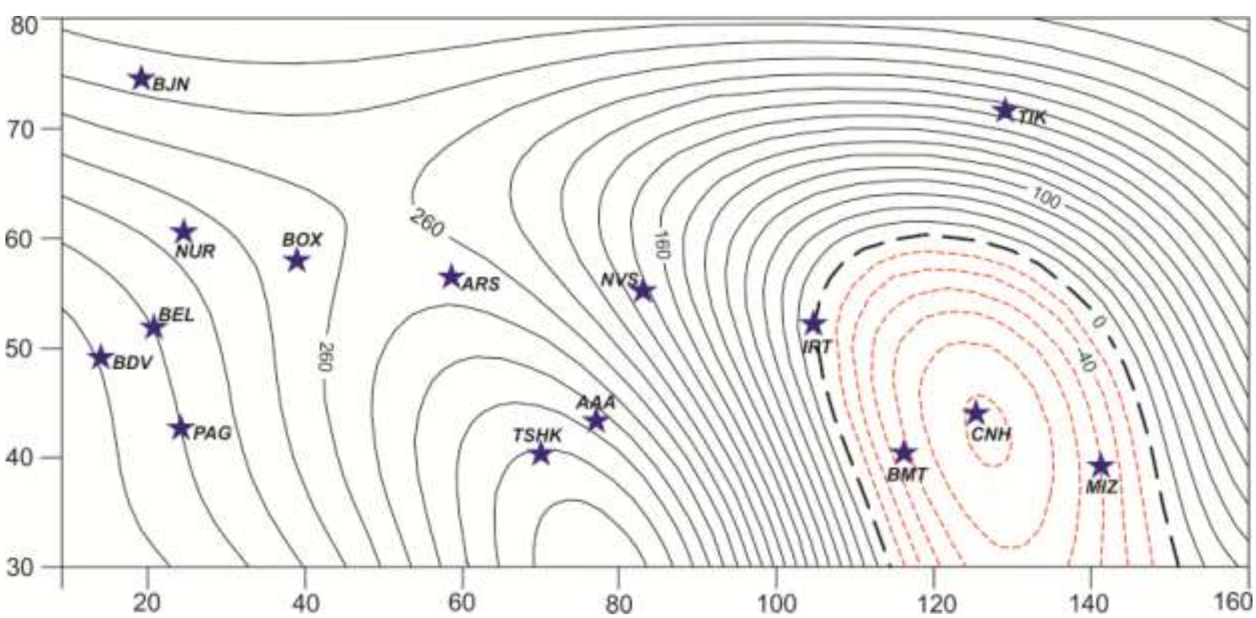

Figure 1: Comparison of the forecast of the secular variation from 2005 to 2010 with real data obtained in magnetic observatories (Demina and Petrova, 2010).

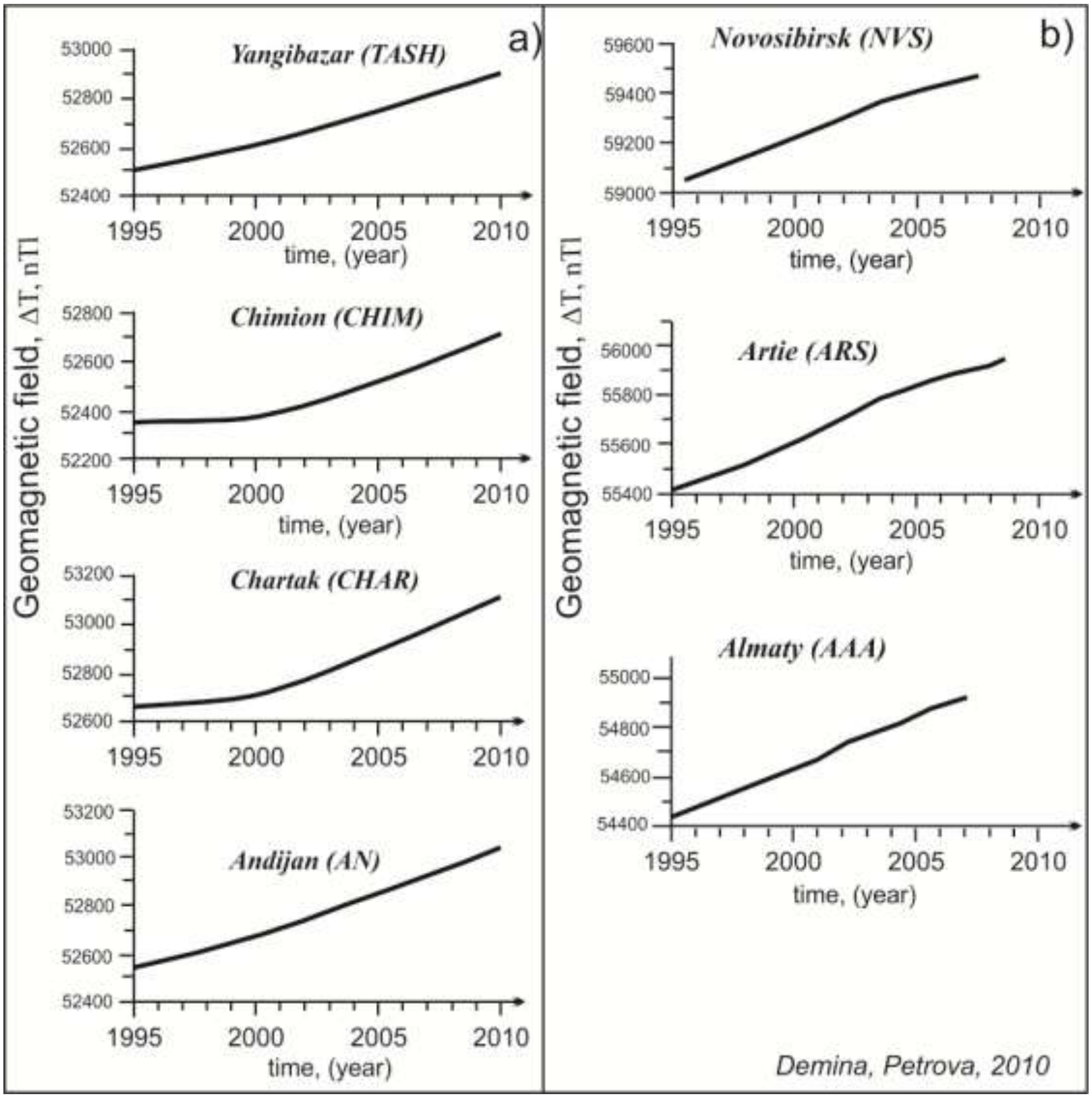

Figure 2: The secular changes were compared with magnetic dates in the observatories of the nearby regions of Uzbekistan

hundreds of years and more, about 60, 22 and 11 years and even less (Golovkov, Kolomiytseva 1976, Yanovskiy 1963, 1978, and others). The sources of 60-year changes lie in the Earth's core, while shorter periods in the secular change seem to be associated with processes in both the core and beyond it; their amplitude being small (first tens of nanoteslas) and they themselves being periodic (Rivin 1977, 1980, Golovkov, Rivin 1976, and others). In some observatories one obtained sharp single features of the secular change having periods about 10-30 years and an amplitude of 100- 300 nTl (Abdullabekov, Golovkov 1974). The nature of the latter components is linked to the processes in the Earth's core as well as to local and regional geodynamical processes. Detailed spatial and temporal analysis of these variations will probably make it possible to distinguish local changes from the global ones.

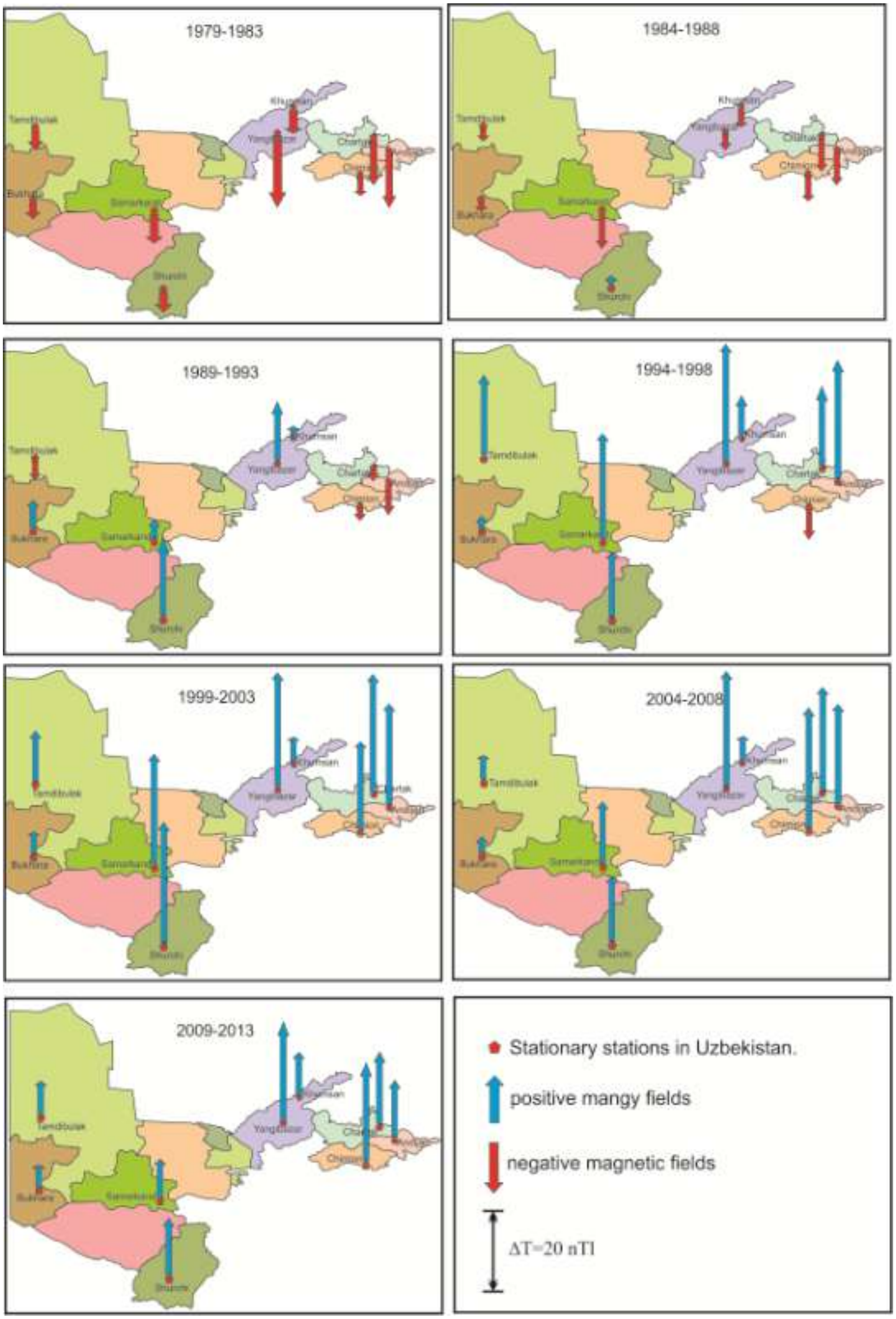

Figure 3: Changes the magnetic fields in Uzbekistan

Hence the changes in the geomagnetic field appear in a very wide temporal spectrum, from fractions of seconds to hundreds and thousands of years. The amplitudes of these variations can be compared by magnitude with local ones, or are even much higher. The characteristic times of the latter are closer. Therefore, the discrimination of local properties in the secular change from a series of observations at a single station is impossible if one uses different frequency and time filters.

The variability of the magnetic field has been examined at 10 magnetometric stationary stations since 1979 under an experimental and methodological program by the Institute of Seismology of the Academy of Sciences of Uzbekistan. The analyzing of the Geomagnetic Field helps to monitor the seismicity of the earth's crust and for prediction of the earthquakes.

Secular variation can be observed in measurements at magnetic observatories, some of which have been around for forty years (the Yangibazar Observatory, for example). Over such a time scale, magnetic declination is observed to vary over tens of degrees.

The secular changes were compared with magnetic dates in the observatories of the nearby regions (Novosibirsk (NVS), Artie (ARS), Almaty (AAA)) and (Yangibazar (TASH), Chimion (CHIM), Chartak (CHAR), Andijan (AN)) in Uzbekistan **(**Fig.2.).

The centuries-long transformation of the magnetic field at stationary stations is defined as follows.

$\Delta T_{secular} = T_2 - T_1, T_3 - T_2, \ldots\ldots. T_n - T_{n-1}$

T_n- the annual average change in the magnetic field

In order to check on the identity of indications by magnetometric apparatus of different types, discrete measurements at every 5-10 minutes were conducted at Charvak and Yangibazar Observatory in a course of a few days. The drawing shows that the readings of all magnetometers were identical.

The values of the magnetic field in Uzbekistan over the past 30-40 years have been studied according to the results of long-term observations at stationary stations (1979-2013), Andijan, Chartak, Chimion, Khumsan, Yangibazar, Samarkand, Tomdybulak, Bukhara and Shurchi. To determine the dynamic field, since 1979, the average annual value for every 5 years is given as a vector.

$$\Delta T_{\text{secular (5 years)}} = \frac{\Delta T_{79} + \Delta T_{80} + \Delta T_{81} + \Delta T_{82} + \Delta T_{83}}{5}$$

The observed data on the secular magnetic field paths at the Andijan, Chartak, Chimion, Khumsan, Yangibazar, Samarkand, Tomdybulak, Bukhara and Shurchi stationary stations are presented. The 1990s declined to -40-50 nT compared with 1979-1980. By 2000, it was changed to -5-10 nT compared with 1990. In 2012-2013 compared with 2000, changes in the magnetic field from + 100 nT to + 500 nT were observed (Yusupov, 2011**).**

From the data of aeromagnetic surveying in the years 1979-2013, repeated ground surveying in the years 1995-2010, and variational observations at Andijan, Chartak, Chimion, Khumsan, Yangibazar, Samarkand, Tomdybulak, Bukhara and Shurchi it has been found that the anomalous field within the magnetic anomaly increases in 10-15 years at a rate of 10 nT per year. Shapiro believes that the anomalous changes are caused by the variation of the residual magnetism of rock due to excessive stresses. Hence the analysis of mean yearly data of the world network of magnetic observatories, together with a long series of measurements in test areas and at points of secular changes, has discriminated a slow variation of the magnetic field with an intensity of 50-100 nT and a characteristic time of 15 year, having the linear dimensions of the first hundreds of kilometres. This type of variation has been explained in terms of tectonic processes in the active areas of the Earth's crust and phases of seismic activity in seismotectonic regions.

Conclusion

Scientists believes that the anomalous changes are caused by the variation of the residual magnetism of rock due to excessive stresses. Hence the analysis of mean yearly data of the world network of magnetic observatories, together with a long series of measurements in test areas and at points of secular changes, has discriminated a slow variation of the magnetic field with an intensity of 50-70 nTl and a characteristic time of 15-20 years, having the linear dimensions of the first hundreds of kilometres. This type of variation has been explained in terms of tectonic processes in the active areas of the Earth's crust and phases of seismic activity in seismotectonic regions.

In conclusion we have identified, the long-term research result of the variation of geomagnetic field around the Uzbekistan; it displays that the local geomagnetic anomalies regional related to the changes of magnetic dates of the observatory of the nearby regions (Novosibirsk (NVS), Artie (ARS), Almaty (AAA)) and (Yangibazar (TASH), Chimion (CHIM), Chartak (CHAR), Andijan (AN)) in Uzbekistan. The research variation geomagnetic field results in the area of Uzbekistan could be used in not only the model preparation process of earthquake and prediction of earthquake but also monitoring seismic activity near the faults zones and the Uzbekistan cities.

REFERENCES

Abdullabekov KN (1989**).** Electromagnetic phenomena in the earth's crust, Tashkent, *FAN* 232 pages.

Abdullabekov KN (2011**).** The most important results of the study of the seismomagnetic effect at the sites of Uzbekistan. *On Sat Problems of seismology in Uzbekistan* **9** 16 - 21

Abdullabekov KN, Golovkov VP (1974**).** Changes in the geomagnetic field and processes in the earth's crust. *Proceedings of the USSR Academy of Science, Physics of the Earth* **3** 93-100.

Abdullabekov KN, Maksudov SKh (1975**)**. Variations of the geomagnetic field of seismically active regions. Tashkent, *Fan* 128 p.

Demina IM, Petrova AA (2010**).** The quality of the forecast of the secular variation of the main geomagnetic field and its influence on the creation of summary maps of the anomalous magnetic field of Russia. *Journal of the Earth Science* **1** 206-215.

Yanovsky BM (1978**).** Earth magnetism. Izd-vo Leningrad State University, 592.

Yusupov VR (2011**).** Ancient variation geomagnetic field in Uzbekistan. *TSTU news. - Tashkent*. 3-4. 154-158.