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Research Article

FEATURES OF INFLUENCE OF GEODYNAMIC CONDITIONS ON THE MANIFESTATION OF HYDROGEOSEISMOLOGICAL EARTHQUAKE PRECURSORS

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ABSTRACT
Currently, mankind does not have the technology which could guarantee the exact time of occurrence of the forecast the next earthquake. Long instrumental observation of the manifestation of the complex prognostic fields on geodynamic polygons in Uzbekistan have shown that the occurrence of many large earthquakes is accompanied by manifestations of hydro-geochemical, geophysical, deformation and other anomalies. These indications include symptoms such as incident energy of the earthquake. These energy curves are obtained empirically and are well described by the theoretical calculations of the distribution of deformation in the area of earthquake preparation. Current situation requires special studies to assess the role of the geological and tectonic features of the earth's crust in in terms of manifestation of precursor anomalies.

Keywords: *Earthquake, fault, seysmogenic zones, hydrogeoseismological*

INTRODUCTION

This paper studies the causal relationship of abnormal changes in hydrogeoseismological fields arising by earthquakes, the study of the mechanism of transfer of predictive perturbations at large distances from the epicenter of different ranks and the influence of the spatial inhomogeneity of the geological environment in the manifestation of abnormalities disturbances related to the beginning of the earthquakes.
To achieve this goal it was necessary to solve the following interrelated objectives:
1. To study the complex manifestations of prognostic fields and to establish a statistically significant abnormal disturbance.
2. Set the main characteristics (duration, distance from point of observation, the amplitude of the manifestations and others). Anomalous manifestations of the studied fields.
3. Comparative analysis of the nature of the symptoms of abnormal perturbation fields and prognostic features of geological and tectonic structure of the area of study.
4. Evaluation of the role of the geological and tectonic features in developing and distributing predictive disturbances in space.

MATERIALS AND METHODS
Currently, a progress in comprehensive analysis of geological and tectonic, geophysical, structural features of the seismically active areas has been made in the field of prediction of place and intensity of possible earthquakes. Abdullabekov *et al.* (2002) studied the seismotectonic potential (the maximum force possible earthquake) of Uzbekistan, within which there is a bulk of strong earthquakes. However, in the field of earthquake prediction time of expected achievements are relatively modest. We do not yet have the technology that could guarantee forecast the exact time of occurrence of the next underground earthquake. Long instrumental observation of the manifestation of the complex prognostic fields on geodynamic polygons in Uzbekistan have shown that the occurrence of many large earthquakes is accompanied by manifestations of hydro-geochemical, geophysical, deformation and other anomalies. Similar results were also obtained in different seismically active regions of the globe which revealed hundreds of cases of abnormal changes in geophysical fields,

hydrogeoseismological parameters, crustal deformation, which are associated with the process of earthquake beginning (Ibragimov R.N. 1978; Catalog seismic earthquake precursors 1986; Sultanhodzhaev A.N. 2006; Abdullabekov K.N. 1989). Studies have been done on the space, time, amplitude, and detection of other abnormal manifestations prior to earthquakes. Statistical methods found that most of identified precursors are registered within the region, limited dependence $R = e^m$, km (Abdullabekov K.N. 1989). or $R = 30R_{sources}$, km (30 times the size of the earthquake source) (Dobrovolsky I.P. et al (1980) and the results of most of the observations interpreted from this perspective.

Ambiguous behavior predictive parameters, even when the earthquake is located relatively close to the point of observation, shows that there are other factors that control symptoms predictive deformation at different scale levels. So far, no established mechanism for the transfer, predictive perturbations over long distances, is known to know the tectonic irregularities during the propagation of the deformation field. Solutions must be sought in the way of taking into account the inhomogeneity of the deformation field due to block-fault structure of the lithosphere. It is known that the structure of crustal blocks hierarchically ordered.

The basis of the interpretation of the results of observations laid seism prognostic results of modeling studies of modern geodynamic situation in Central Asia. In the works (Osokina D.N. and Tsvetkova N.Y. 1982) the estimation of modern geodynamic situation in Central Asia and the Middle Tien-Shan was done using experimental laboratory simulation of crustal structures, by optical simulation. The basis of the simulation scheme laid geodynamic zoning of pre-Mesozoic structures of Central Asia. According to this scheme, now Central Asia is under the influence of three different directions of horizontal compression forces, causing migration of “internal statistical stress” in the lithospheric blocks. The simulation results showed that the migration of the stresses in the central part of the region due to three horizontal multi-directional compression forces is in direct proportion to the regional faults, in particular, on their spatial arrangement with respect to the directions of compressive forces. One second of the salient features of the results is the formation of large areas of sprains in the simulation where tectonic stress is zero. As a result of decoding mechanism and formation of these zones, the authors concluded that the strip-shaped stress distribution is a shift of large blocks of the Earth's crust, situated between the regional faults. These offsets cause fault activity, due to the regional (planetary) compressive force area of Central Asia in three ways. The most active of the major elements of the study area are tectonic blocks, which are the boundaries of the regional faults. Each tectonic unit characterized by its own picture of the distribution of tectonic stresses and tectonophysical state, depend on a number of factors. Among the active blocks there stand the triangular block that simulates the Fergana basin and prismatic block simulates Chatkal-Kurama region. The most intensive displacement occurs in Fergana basin. The displacement unit is accompanied by the neutralization of stresses along the North-Fergana fault and their concentration along the element simulating the Talas-Fergana fault. This enabled the authors to conclude that the faults of northeast strike, both in the Fergana Valley, and in the Chatkal-Kurama, as well as areas of interfaces faults with the North Fergana structure is earthquake-prone tectonic elements (Nurmatov *et al*. 2015).

Tectonic block that represents the Fergana basin, is shifting to the northeast and tectonic stresses Besopano-South-Fergana fault is weakening. The displacement unit can cause a vertical fault activity and may be accompanied by earthquakes, the mechanism of which is related to the geodynamics of the Fergana Basin.

Here, in terms of modern geodynamics Chatkal-Kurama region and zone Bessopano-South-Fergana fault, we tried to interpret the features of display precursors Tuyabugiz earthquake in May 25, 2015 with M = 5.6. Tuyabugiz instrumental epicenter of the earthquake 25 May 2013 is confined to the south-western end of the seismogenic zone. Angren and macroseismic epicenter was more inclined to the south-western end of Nurekata seismogenic zone. Nurekata seismogenic zone in the northeast articulated with Pskem-Tashkent seismogenic zone. Thus, all three seismogenic zones in a separate sites merge or branch out to form a single geodynamic system (Figure 1).

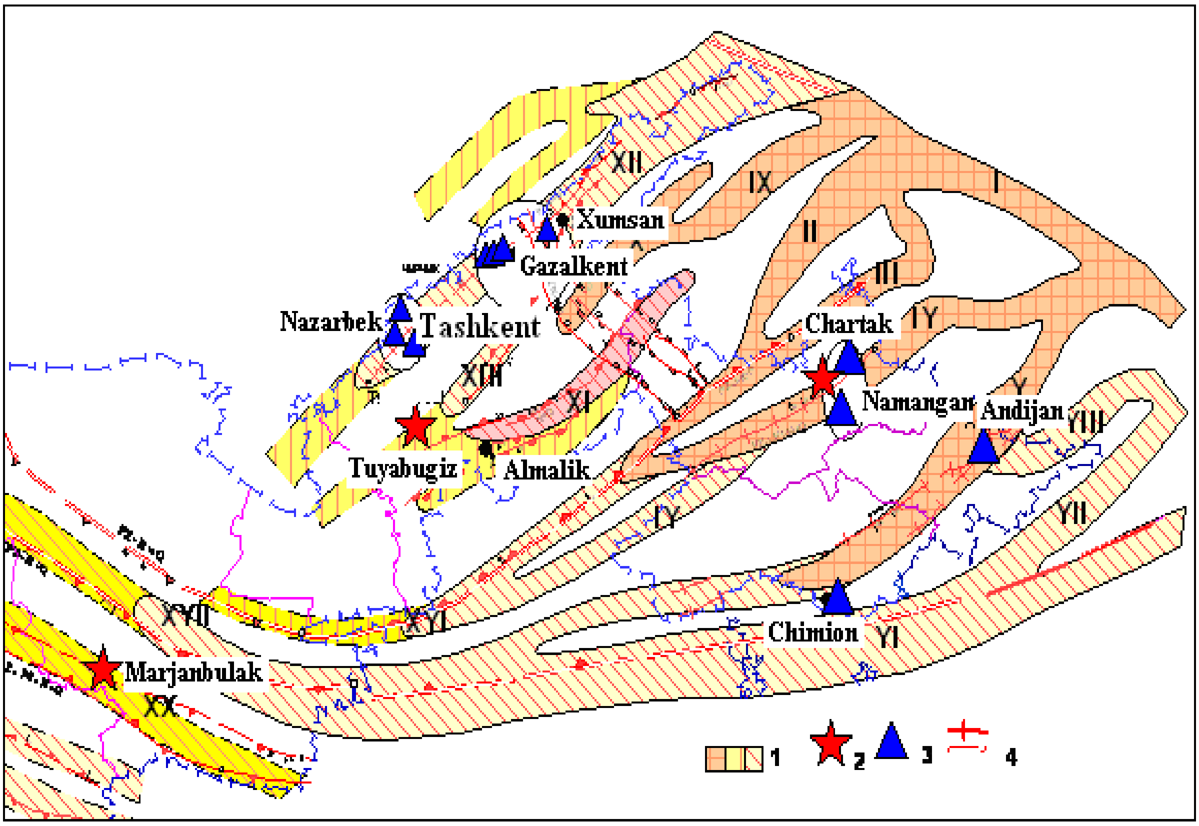


Figure 1: Seismogenic zone, active faults, earthquake epicenters and observation stations. 1 - seismogenic zone (XII -Pskem-Tashkent; XIII - Nurekata; XI - Angren; II - Chatkal-Atoynak; III - Fergana; IV - Namangan; V -Andijan; VI –South Fergana); 2 - the epicenter of the earthquake; 3 - prognostic station; 4 - faults of the crust.

Hydrogeoseismological observations during the occurrence of an earthquake in some water stations by Tashkent region and the Fergana Valley recorded abnormal changes in observed parameters. According to the spatial arrangement and affinity to these tectonic structures water points divided into three groups (Figure 1).

The first group water station (station "Ozodbosh", wells: “Minora, DAN, Chatkal” and spring “Ozodbosh”) is located in the central part of the Tashkent-Pskem seismogenic zone. At this region the seismogenic zone is articulated with Nurekata zone. The distance from the earthquake epicenter to water station R ≈70 km.

The second group water points located in the south-western part of the Tashkent-Pskem seismogenic zone (the distance to the epicenter of the earthquake R ≈ 30 km). It wells: “Textiles, Institute of melons and Nazarbek”. Although the distance of the water station are 2 times closer to the epicenter than water station of first group, but between Nurekata and Tashkent-Pskem seismogenic zones, has the aseismic block dedicated to the Chirchik basin with a width of approximately 20-30 km.

The third group water station is located 225 km from the epicenter, in the Namangan seismogenic zone (station "Chartak"). Between Nurekata and Namangan seismogenic zones are still three separate seismogenic zone.

Table 1 show all the symptoms of abnormal precursors of water station 3 groups during the preparation and accomplishment Tuyabugiz earthquake (the number refers to the number of crosses water station at each station). Regardless of the amplitude and duration of abnormalities, they are distributed in stages: presentation and recorded before the earthquake (second column - to-seismic. anomaly), during an earthquake (the third column - KO-seismic. anomaly.) and earthquakes (the fourth column - post-seismic. anomaly). The other column shows all the information about the observed precursors on three group's water station located on different seismogenic zones. It can be seen from the table, on the water station group 1 anomaly, except for isolated cases, recorded before the quake. The closest and distant water stations (2 and 3 group) responded to the earthquake training much later, *i.e.*, about 50% of the apparent anomalies in time of earthquake, and the rest after the quake.

Table 1.

Parameters	BEFORE- seysm. abnor malities.	DURING seysm. abnor malities.	AFTER- seysm. abn ormalities.	one seysmogen. area. R = 70km	On dr.seysmogen. area (block) R =30km	On dr.seysmogen. zone. R = 225km
CO_2	■■■■	▲	▲ ●●	■■■■	●●	▲▲
He	■■■■	●	●●	■■■■	●●●	
He (Ingham)			●		●	
H_2	■■■	▲	● ▲	■■■	●	▲▲
Cl^-	■	●●	■	■■	●●	
HCO_3^-	■■■ ▲	●	▲	■■■	●	▲▲
Rn		●●			●●	
N_2	■■■■■	▲	▲	■■■■■		▲▲
O_2	■■■■	▲▲		■■■■		▲▲
pH	■	■		■■		
Eh	■	■■ ▲		■■■		▲
CH_4		▲				▲

Note: ■ - abnormal manifestations of group 1 water point; ● - 2 of the group; ▲ - 3 group.

Figure 2 is a graph which displays the parameter such as content of CO_2 in the groundwater observation points during the emergence and accomplishment Tuyabugiz earthquake. As can be seen from the figure, the abnormal changes in the water station, located at the junction Nurekata and Tashkent-Pskem seismogenic zones ahead of the phase changes in other water stations. In the first group water station abnormal variations are predictive in nature, but in other areas they appeared at the time of or after the occurrence of a seismic event. The water station of the Tashkent-Pskem seismogenic zone located relatively close, but on the other tectonic structure abnormalities were observed during the accomplishment of the earthquake, and in remote water station Namangan seismogenic zone (Art. Namangan) after the occurrence of an earthquake. This indicates that the strain field associated with the preparation and occurrence of Tuyabugiz earthquake, quickly spread.

Earlier, similar results were obtained for Uchkurgan 1995 earthquake. In 1995, October 8 earthquake occurred in Uchkurgan with a magnitude of 5.3 (Figure 1). Abnormal display of a number of parameters (T, R pH, H_2, He, CO_2, HCO_3^-) were observed in the wells of stations "Chartak", "Chimion" and "Hodjabad".

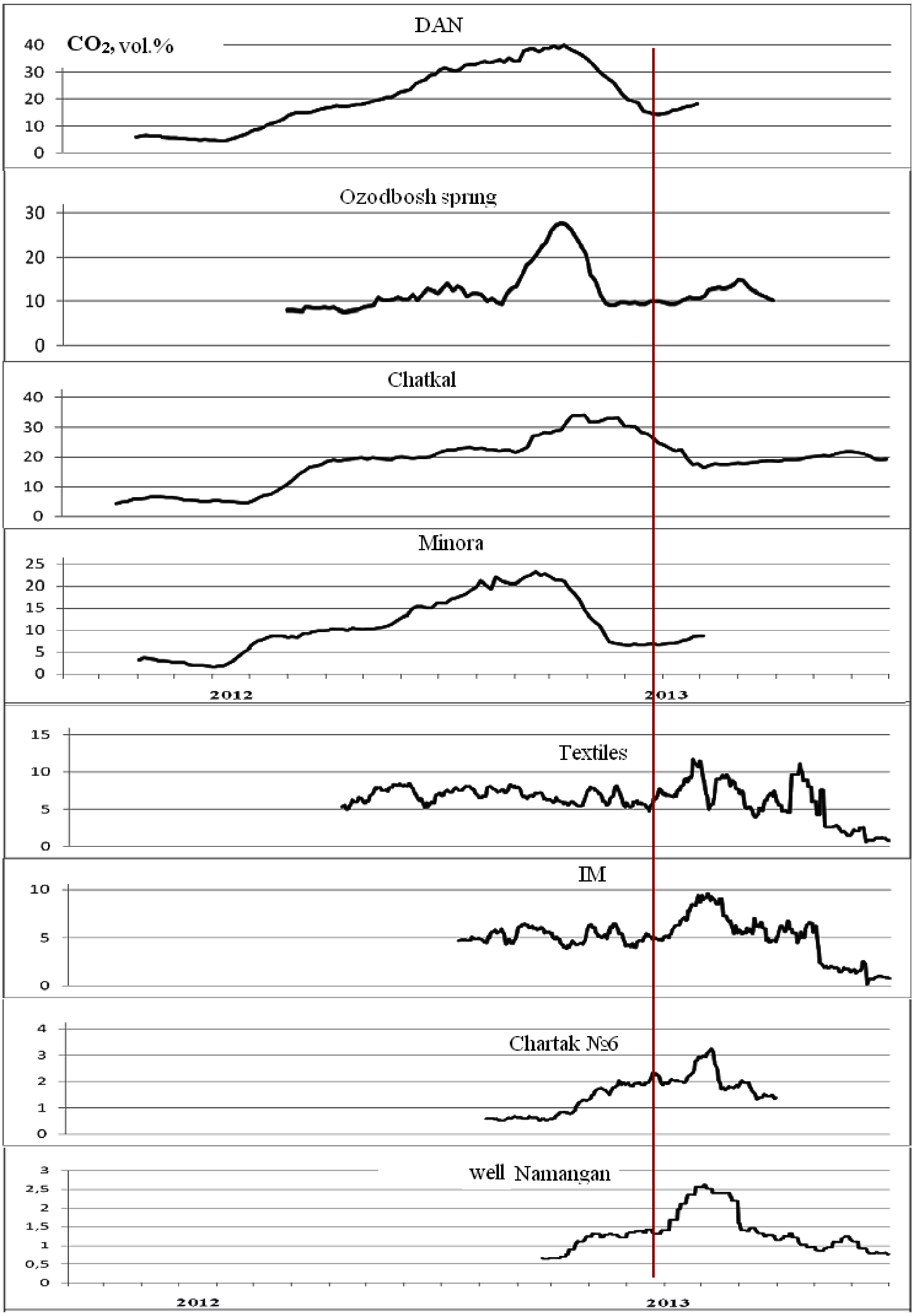


Figure 2: Variations of CO_2 at the stations of Tashkent (groups 1 and 2) and Chartaq (3 group) during Tuyabugiz earthquake

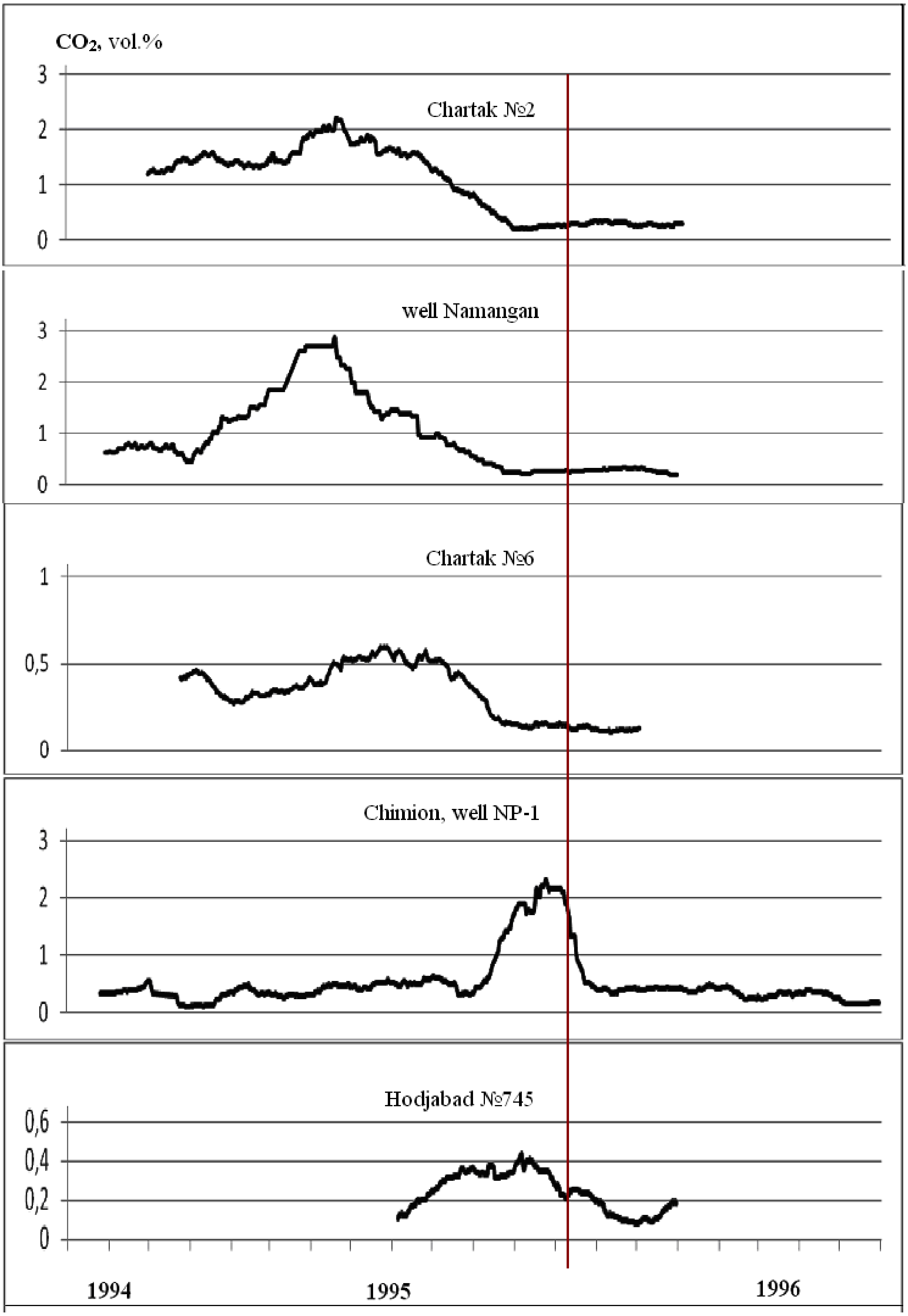


Figure 3. Variations of CO_2 at the stations Chartak, Namangan, Chimion and Hodjabad during Uchkurgan earthquake.

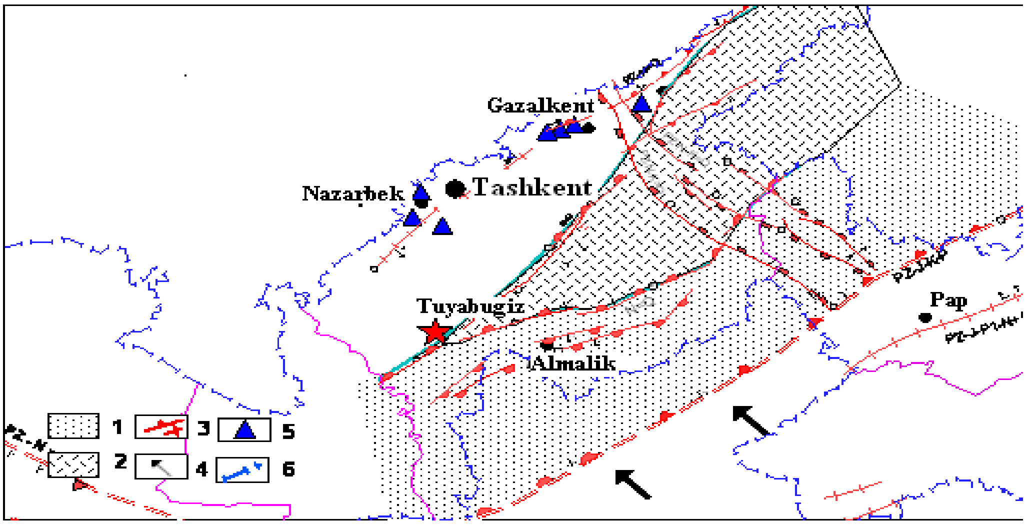
Table 2 provides information on abnormal variations in groundwater precursors in Fergana geodynamic polygon during Uchkurgan associated earthquake on 08.10.1995, (M = 5.3).
Figure 3 are graphs displaying CO_2 content in groundwater observation points during the emergence and accomplishment of Uchkurgan (08.10.1995, M = 5.3) earthquake.

Table 2

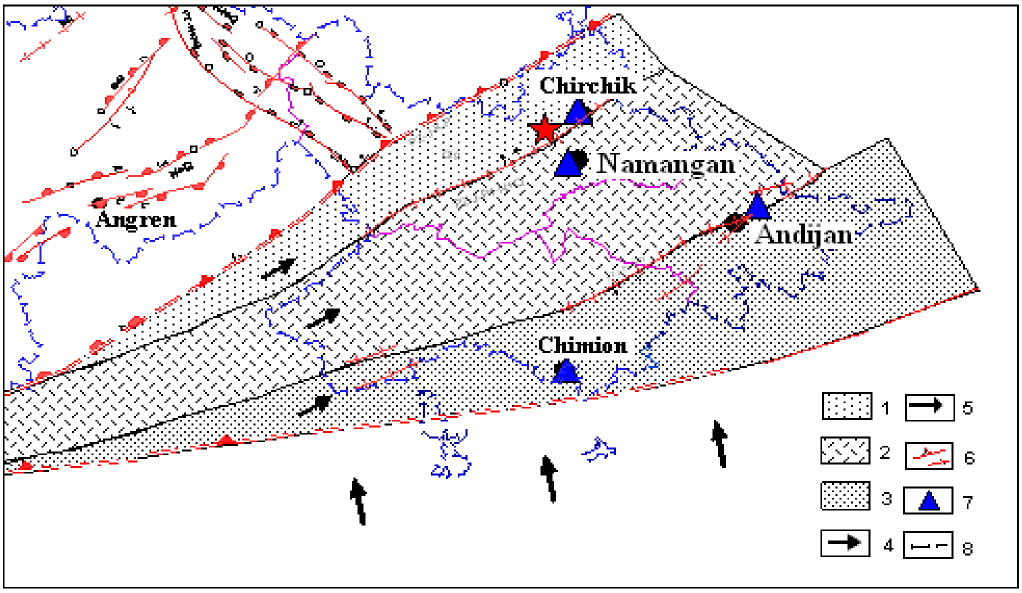
parameter	BEFORE-seysm. abnormalities.	DURING-seysm. abnormalities.	AFTER-seysm. abnormalities.	one seysmogen. zone. (Chartak) R=10 km	on the other seysmogen. zone. (Hadjabad) R=93 km
CO_2	■■■ ▲			■■■	▲
He	■			■	
H_2	■		■	■■	
Cl^-		▲			▲
HCO_3^-		■		■	
Rn	■■	■		■■■	
N_2	■			■	
O_2	■	▲		■	▲
pH	■	■	▲	■■	▲
Eh	■ ▲	■		■■	▲
CH_4	■			■	

Location of earthquake epicenters in different structural-tectonic zones causes deformation of rocks in different parts, and, thus, affects the nature and intensity of the precursory anomalies at different observation points.
Possible causes of the observed sequences manifestations of registered ground precursors appear to be corrrelated to the contemporary geodynamic state of crustal blocks in East Uzbekistan. Fig. 4 shows a diagram of geodynamic Chatkal – Kurama region (a) and the region and the Fergana Valley (b). The boundaries are marked on the basis of geoblocks, the spatial position of seismically active faults, which are accepted as the basis for allocation of seismogenic zones. The first of the selected blocks, bordering North Fergana and Angren faults is perpendicular to the current regional efforts, and second, a triangular shape, bordering the Angren and Nurekata faults located at an angle to the force. Compared with the first block, the second block of the triangular shapes are more prone to shifting of thus to generate earthquakes. Tuyabugiz earthquake, apparently, is a consequence of the interaction of both blocks as a result of regional efforts. This is evidenced by manifestation of hydrogeoseismological precursors in the north-eastern part of the Tashkent-Pskem seismogenic zone. These points are located at the junction of the second block with the north, bordering on Karzhantau fault and are located in the area of dynamic influence.
Other points of this area, although closer than the first group of items, but they are outside the influence of the activated unit and in this regard the abnormalities appeared after a seismic event. The remaining points are located further in the area of North Fergana flexure-tensile zone and anomalies registered in them, apparently, are a consequence of the overall revitalization of the regional geodynamic units of higher rank.
Abnormal changes associated with Uchkurgan earthquake that occurred in the North Fergana flexure-tensile zone, as well as in the first case, in different locations have different characteristic time. Stations Chartak, Namangan abnormal changes account for 12-13 months prior to the earthquake. In stations Chimion and Harabek they appeared for 5-6 months before the event, although these points are at a considerable distance from each other. As a result of simulation, it is found that due to the impact of external forces, the Fergana block, bordering the North-Fergana and the South-Fergana faults, moving in a northeasterly direction. The question naturally arises - Fergana block moves as a single unit, or the force on the block is redistributed between the tectonic units of a smaller size. We know that in recent years, along with the North-Fergana and South-Fergana faults of high seismic activity are different and the same name flexure-explosive area. This indicates that these regions are

the place of unloading forces with external impact. Apparently, the regional power, superimposed on the local stress state of the smaller units, leads to activation of the seismic source area. Detection of precursors of earthquakes in remote areas is a consequence of regional processes, with shorter characteristic time.



a



b

Figure 4. Geodynamic scheme Chatkal-Kurama region (a) and Fergana valley (b).
1-3 - large blocks of the Earth's crust; 4 - direction of regional efforts, 5 - the direction of the Fergana block, 6 - large cracks which are the basis of seismogenic zones, 7 - stations hydrogeoseismological observations, 8 - border of the Republic.

RESULTS AND DISCUSSION

It was established that the occurrence of many large earthquakes is accompanied by manifestations of hydro-geochemical, geophysical, deformation and other anomalies. In distributing the precursors to the great distances the decisive role is played by the magnitude of tectonic blocks, which extends along the boundaries of tectonic activity momentum.

The degree of "sensitivity" of individual stations, the nature, intensity and time of observable precursors depends upon the difference between the structural-geological and seismotectonic conditions of the location of earthquake sources and observation points, as well as the intensity of the coming earthquake.

Based on these studies we can conclude:

- Traditional manifestation of precursors at various distances and the size of the earthquake source cannot always be correlated;

-manifestation of the earthquake and related earthquake precursors may give information of existing faults and associated seismic zone;

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