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TO EARTHQUAKE PREPARATION MODELS, BASED ON HYDRO-GEOCHEMICAL DATA

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INTRODUCTION

Dynamic properties of underground waters give a basis for monitoring Earth crust geodynamics' processes. Hydrogeochemical data have been analyzed from the thermal water of Khoja-Obigarm, Yavroz, Shaambary in the Tajikistan seismic active areas on the determination of radon, pH value and electrical conductivity.

ARRANGEMENT OF THE OBSERVATIONS AND THE RESULTS

The observations have been conducted at the of thermal water deposits Khoja-Obigarm, Yavroz, Shaambary in the Tajikistan's seismic active areas. The depths of bore holes were about 50, 100 and 1300 meters, average debits were equal to 1.50, 0.35 and 0.90 liter/s with hydro carbonate-sulfate-chloride-potassium-silicon, chloride-sulfate-potassium and sulfate-chloride-potassium waters respectively. The variation of the pH in particular for Shaambary site has shown very distinct periodicity of about 14 days, caused evidently by crust deformational processes under the lunar tides, and failure of this periodicity approximately 10 days before the Dushanbe earthquake on 18 August 2006, M = 4.5, hypocenter depth 2.5-5.0 km at the epicentral distance of 20 km (Fig. 1).

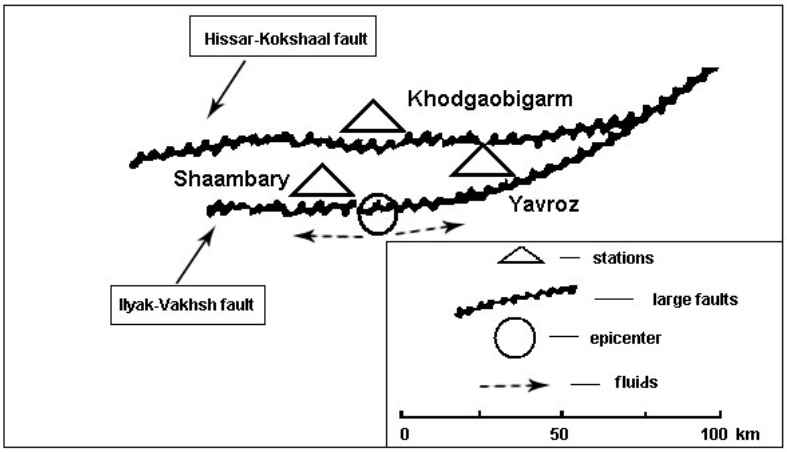

Figure1. Scheme of the observational site. The legend is at the right bottom corner.

The running average is shown by the bold line on the Fig.2. The positive long term trend stipulated seemingly by annual periodicity can be seen as well on the Fig.2.

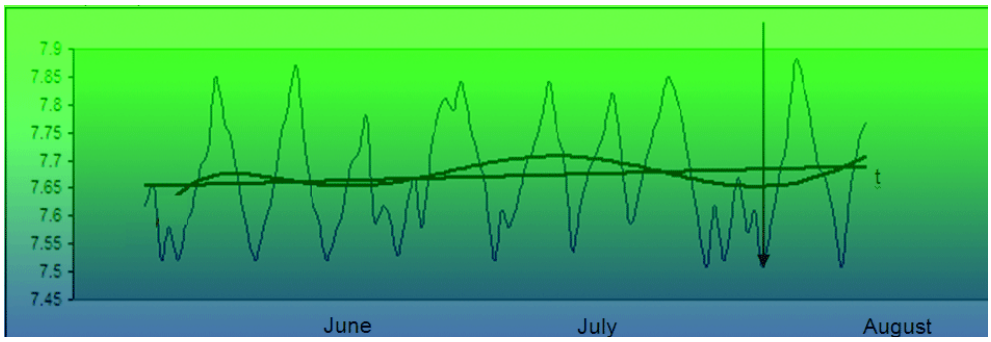

Figure 2. pH index of the Shaambary thermal water deposit in July-August 2006. The arrow shows the Dushanbe 18 August 2006 earthquake moment.

THE MODEL REPRESENTATIONS

Stresses near the focus and near to an earthquake preparation zone amount to about 10^9 Pa and they descend up to the background values within the radius r according to the formula, derived by Dobrovolsky [2000] –

$$\lg r[km] = 0.43M, \qquad (1)$$

where r is equal to about 100 km for the earthquake of magnitude 4.5.
In water samples of Khoja-Obigarm and Yavroz the pH anomalies contained some noise, probably because of the superficial chinks caused by infiltrated underground waters from atmospheric precipitation and brooks flowing nearby. Clear Shaambary site effect may confirm that elision waters play the prevailing role here. The epicenter of the earthquake is near Ilyak-Vakhsh fault, passing through the same line the Shaambary is located on (Fig.1). The fault zone represents the porous and cracked rocks and consequently the fluids can propagate through them up to long distances of hundreds to thousand kilometers. The fluid flows along the fault are shown by the dashed arrows (Fig.1).
The area of preparation of a tectonic earthquake depends on its magnitude and is described by means of the formula (1) set forth. The linear size of an earthquake source can be determined by the empirical formula, derived by Riznichenko [1976]

$$\text{Log } R_o\,[km] = 0.42M\text{-}1.37, \qquad (2)$$

where R_o is the mean radius of earthquake source.
In the case of the Dushanbe earthquake according to the formula (1) the preparation area radius is around 100 kilometer and the mean radius of the source (2) is approximately 2.5 kilometer.
Ability of fluids to extend along within a fault from area of epicenter formation on such distances has been found confirming not only by the hydro geochemical anomalies, but, as was shown by Rikitake [1976], also for the anomalies of some other geophysical fields. For example, in variations of a local geomagnetic field, obtained in particular by Skovorodkin et al. [1978], Johnston [1997] and Karimov [2007]. According to the general representations about seismic tectonic process of Dobrovolsky [2000], the integrant stress in the earthquake preparation zone displaying mean term stage has a bay-like shape. The main shock pertains to the stage of approaching of anomaly to this level. This indicates background tectonic movements of tectonic plates and geoblocks, pressing and colliding on each others.
One can observe in investigations of pH, Rn and electro conductivity parameters the time runs with periodicities about 14 days and 12 hours. 14 day period of the pH index run is shown in the Fig.2. The detailed work has been carried out to identify daily periodicity in chemical composition and conductivity of underground waters under sampling with the discreteness of 1 hour by the order of magnitude. The periodicity of pH variation for a day has been observed, but conductivity has more pronounced effect. About 12 hours periodical anomalies vary in amplitudes up to 20 mSm/m at Khoja-Obigarm, 60 mSm/m at Yavroz and 160 mSm/m at Shaambary.

The Fig.3 demonstrates 12 hour averaged periodicity data in electro conductivity of waters extracted from bore holes Khoja-Obigarm, Yavroz and Shaambary. This periodicity is superimposing on to the background trend stipulated seemingly by lunar monthly run.

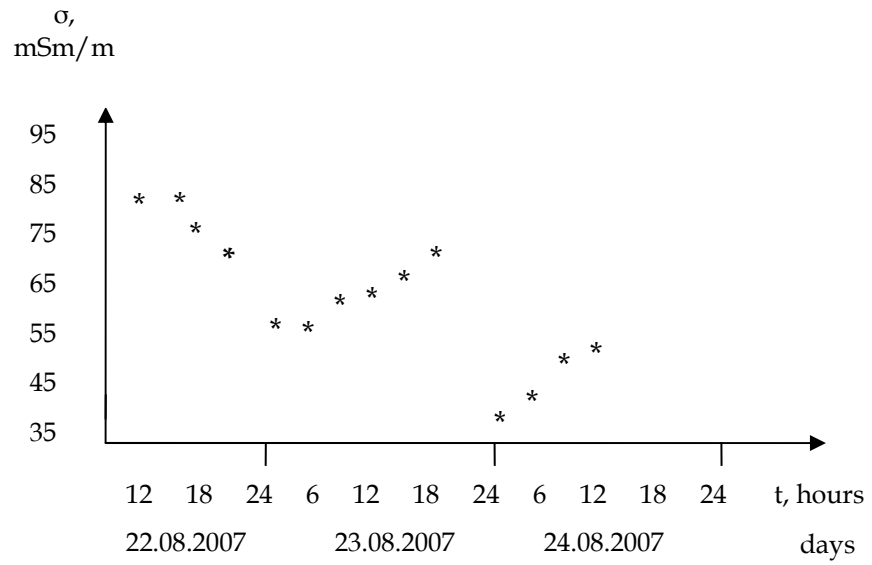

Figure 3. 12 hour periodicity in electro conductivity of water extracted from Yavroz borehole.

INTERPRETATION AND DISCUSSION

The following interpretation for such periodical variations in pH index and electro conductivity is suggested on the basis of model representations for seismotectonic processes of Dobrovolsky [2000]. The noise represents the vibrations of earth's crust The observations on lunar and solar tides by Starkov et al. [1988] conducted in the Tajikistan's seismic regions show that relative crust deformations varies between 10^{-9} to 10^{-8} in bulk parts of geoblocks and up to 10^{-6} in geoblock and fault borders, where the wings are less constrained. Relatively large crust deformations on fault vicinities promote active fluid flow dynamics along with the faults, which contain rocks with high porosity relatively to bulk geoblock rocks. So in a regular state the geoblocks are oscillating under the regular periodical tidal impact and fluids are propagating through the porous faults with the same periodicities.

Once any adjacent geoblocks have entered into cohesion there will be the inhomogeneous "inclusion" nucleated and it get started to grow in volume. The tectonic movements at the fault between geoblocks stop and therefore movement of the fluid flow fills up the local space. The energy pumping into the inclusion continues to grow and starting from critical barrier the "inclusion" begins to collapse. When hardness of the "inclusion" descends to low levels the next tidal impact will tire the geoblocks' cohesion sharply and thus the earthquake originate. Afterwards the geoblocks again start vibrating with the regular background noise level of the crust.

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