

STRAIN VARIATIONS AT THE GEODYNAMIC TEST SITE IN THE TIEN SHAN AND THE LOCAL EARTHQUAKE OF 12.02.2013

G.A. Sobolev¹, S.I. Kuzikov², V.D. Bragin², N.A. Sycheva²

¹*Schmidt Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, Russia*

²*Research Station, Russian Academy of Sciences, Bishkek, Kyrgyz Republic*

Abstract. The results of complex geophysical observations conducted at the Bishkek geodynamic test site, the Tien Shan, are presented. The seismic network KNET operating at the test site enables the recording of earthquake with the minimum energetic class $K=7$ and determining their focal mechanisms.

The observations of deformations of the Earth's crust were carried out for many years at the Tien-Shan territory and adjacent regions using the methods of satellite geodesy. The weekly measurements were organized at three sites with linear sizes up to 3 km in 2012; their first results are discussed. The special attention is drawn to strain recording in the fault zones, which allows the estimation of variations observed in tectonic stresses.

Variations in several parameters: distances between different observation points, surface strains using GPS data, and electrical resistivity at various depths were studied and compared with the seismicity and focal mechanisms of earthquakes. The analysis of the data provided the possibility to estimate the geodynamic situation during the local earthquake of 12.02.2013, energetic class $K=10$. The depression of the Bishkek geodynamic test site at ~20 mm was revealed several days before the earthquake. The width of the nearby tectonic fault increased up to 8 mm, which corresponds to the variation in effective tectonic stress by about 7 MPa. It is concluded that the changes in geodynamic conditions contribute to the occurrence of the local earthquake.

Keywords: geodynamics, seismicity, electrical resistivity, earthquake, displacements, deformation, stress.

Introduction

Regular complex geophysical studies are conducted by scientists of the Russian Academy of Sciences at several test sites located in different regions of Russia. The largest complex of observations involving registration and analysis of more than 13 parameters is fulfilled at the Kamchatka test site in subduction zone; the second largest test site is located in zone of the Baikal rift. Observations with the smaller number of measured parameters are performed at the test sites on the Kuril Islands, Sakhalin Island, Primorye, in the south of the Khabarovsk territory, in the Gorny Altai; these test sites present methods of space geodesy, gravimetry, magnetometry and electrical prospecting. The following institutes take part in the studies at the mentioned test sites – Far Eastern (Institute of Volcanology and Seismology, Pacific Oceanological Institute, Institute of Marine Geology and Geophysics, Pacific Institute of Geography) and Siberian (Institute of the Earth's Crust, Institute of Petroleum-Gas Geology and Geophysics) Branches of the RAS, Geophysical Survey of the RAS and its Kamchatka branch. A special place has the Bishkek geodynamic test area, the Tien Shan, zone of continental seismicity. This test appeared to be located on the territory of the Kyrgyzstan after the collapse of the Soviet Union; however the RAS Scientific Station that operated in Soviet times still functions. A unique feature of the test area is a periodic impact of the Earth's crust by high-power electromagnetic pulses that allowed discovering the seismicity response to this influence [Sychev *et al.*, 2008, 2010]. The observations of deformations of the Earth's crust were carried out for many years at the Tien-Shan territory and adjacent regions using the methods of satellite geodesy. As a result of these observations were determined the main characteristics of block movements [Kuzikov, Mukhamediev, 2010], detected relations

between variations of rock electrical resistivity at the deep layers of the crust and its surface strains [Fridman *et al.*, 2005].

The Bishkek test site has the seismic network KNET that enabled the creation of homogeneous seismological catalogue with the minimum energetic class $K=7$. Using this catalogue were detected the spatial features of earthquake foci distribution within the test site and were calculated hundreds of earthquake mechanisms [Sycheva *et al.*, 2005]. It is shown that seismicity and earthquake focal mechanisms react to the changes in field velocity of the moving surface calculated according to *GPS* data [Sobolev *et al.*, 2010]. The deep structure of the test site and adjacent regions was studied in detail by magnetotelluric sounding [Rybin, 2011; Rybin *et al.*, 2015].

In 2011 the Scientific Station of the RAS was given a task to study the local deformation variations at the Bishkek test site due to the earthquakes. Moreover, a special attention was paid to the registration of deformations in fault zones. Amplitude of both horizontal and vertical movements in the fault exceeds their level in adjacent rock massifs [Kuzmin, 2004], that makes it possible to shift to the estimation of changes in tectonic stresses. The weekly linear-angular measurements were organized to accomplish this goal in 2012 at KENTOR, POLIGON and ALMALY sites (Fig. 1). Their results are discussed in the given article.

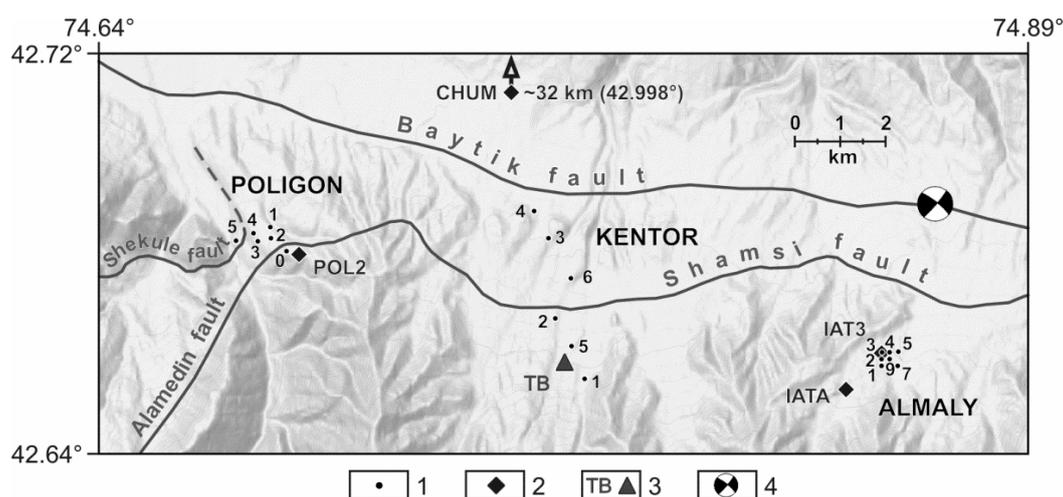


Fig. 1. The layout of the studied area with locations of (1) linear-angular observation sites POLIGON, KENTOR and ALMALY, (2) *GPS* measurement points *IATA*, *IAT3*, *POL2*, *CHUM*¹, (3) sounding stations of field formation method in the far-field zone and (4) the earthquake epicenter of 12.02.2013 (focal mechanism). Lines are active faults. On each geodetic site are given the numbers of benchmarks

When observing the modern movements of the Earth's crust, in geological meaning are interesting active faults that break the integrity of the Cainozoic formations within the study area. The main object of the study presented in the article is the Shamsi fault with sublatitudinal strike and a southern dip at an angle of 50–60° (see Fig. 1). On the plane of this rupture the Paleozoic basement (granites, granodiorites, etc.) is upthrown onto Paleogene-Neogene terrigenous formations of the northern downthrown block. In its western closing the Shamsi thrust passes into the Alamedin left strike-slip (or reverse-strike-slip) of the north-eastern strike. At the same time, a matching kinematic pair of faults was formed for tectonic regime of the long time meridional shortening. The plane of Alamedin strike-slip has a steep dip to the south-east at an angle of 70–80°. The geodesic site POLIGON is located at the

¹ CHUM station is located about 32 km to the north of the area shown in Fig. 1

western boundary of the studied area (see Fig. 1) and includes the eastern closing of the Shekule fault with the north dip of the plane at the angles of 40–50°, which is quite unusual for the tectonic structure of the Chuya depression. On the plane of this rupture, the terrigenous-effusive formations of the Devonian are upthrown from the north on the same section of the Cainozoic deposits.

Unfortunately, the degree of exposure of the studied area does not allow us to directly observe the branch zones of active faults, but they are traced by turfed areas of tens of meters separating a clearly different Paleozoic and Cainozoic formations. Besides, rocks nearest to the fault are characterized by more intensive fracturing and content of quartz-calcite stringers. Quite often in the fault range occur geomorphological benches.

There is a fault of west-north-west striking and of the south dip at an angle of 60–70° on the southern border of Baytik depression in the form of clear geomorphological bench. Both walls of this rupture are composed by Paleogene-Neogene-Quaternary deposits; tectonic structure of the fault indicates its thrust character.

Results of baseline lengths measurements

All benchmarks of KENTOR, POLIGON and ALMALY sites represent fundamental reinforced concrete pillars that are installed according to the rules of laying the corresponding observation points and can be used for almost all types of geodesic observations. Linear-angular measurements were carried out using tacheometer *Leica* (Total Station) with electronic recording of a number of parameters. The main parameters are the length of the measured line and vertical and horizontal angles.

In this paper are analyzed only distances obtained automatically using the propagation time of infrared ray from the benchmark with tacheometer to the benchmark with reflector and back. For each individual measurement of the baseline corrections are made to the instrument in the form of by the average values of temperature, pressure and humidity, measured at two benchmarks of the baseline. Moreover, for each measurement are made from 20 to 50 individual readings of tacheometer with the following averaging. Direct linear-angular measurement from the benchmark 1 to the benchmark 2 is accompanied by the reverse measurement (from the benchmark 2 to the benchmark 1) for 5 min to 2 h depending on the number of the used instruments and the complexity of movement pattern between the benchmarks.

When analyzing the results, the measuring lines were divided into two groups. The first group consists of lines intersecting the emergent trace of the Shamsi fault transverse its striking, lines of the second group are not crossing the fault (Table 1). There are no lines crossing the fault trace at the ALMALY site, therefore its I group includes submeridionally oriented lines (in Table 1 are shown in bold).

Table 1. Measuring lines used in the analysis of the results of distance measurements at the Bishkek test site

Test site	Position of measuring lines relative to trace of the Shamsi fault	
	Group I (crossing)	Group II (non-crossing)
KENTOR	K1-6, K5-6, K2-6, K2-3	K1-5, K2-5, K3-6, K4-6
POLIGON	P0-1, P0-2, P0-3, P0-4	P1-2, P2-3, P2-4, P3-4
ALMALY	A1-4, A1-5, A7-4, A7-5	A1-7, A2-9, A3-4, A4-5

The measurement results were considered in the forward and reverse directions, i.e. eight measurements were taken into account in each group at the three test sites. Preliminary review showed that measurement results contain errors that apparently have anthropogenic nature. These errors usually includes sudden emissions identified by algorithms and search programs [Kobzar, 2006], as well as changes of the level 0 or polarity, that are several times higher than the value variations at consecutive measurement points. In such cases were made corrections that led the errors to the results of the previous measurement.

Leveling sessions within the sites were performed only twice a year. It was found out that values of vertical movements are not bigger than several millimeters and are comparable with measurement errors. They were not taken into consideration since they practically don't affect the line length between benchmarks [Kuzmin, 2004] established that the possible occurrence of short-time vertical movements in the fault zones still can't be excluded. Cases of changes in surface deformations near fault zones were noted repeatedly before the earthquakes [Pevnev, 1988].

The regular observations were started on 05.06.2012 at the mentioned test sites, involving measurements approximately once every 8 days. The time interval is limited by the processing date of the latest *GPS* data, i.e. 14.10.2015 and includes the analyzed results. Measurements at the POLIGON site were carried out on 11 baselines with the length from 214 to 1146 m; at the KENTOR site – on 10 with the length from 680 to 2450 m; at the ALMALY site – on 23 with the length from 149 to 1750 m. Measurements on all lines in each session required 1 day. Results of *GPS* measurements were presented in *EURA-2008* reference frame with averaging of coordinates for 4–5 days.

Examples of observation series at the KENTOR site are given in Fig. 2 separately for lines in group I (see Table 1) (Fig. 2, *a*: lines K1-6*, K2-3* – direct course, K6-1, K3-2 – reverse), and for lines in group II (Fig. 2, *b*: lines K1-5*, K3-6* – direct course, K5-1, K6-3 – reverse). The beginning of measurements on each line was taken as 0, i.e. relative length variations of each line were studied. Two things should be noted in the diagrams given below. Firstly, the spread of values for the lines crossing the fault (group I, Fig. 2, *a*) is approximately twice as large as the spread for lines not crossing the fault (group II, Fig. 2, *b*), and, secondly, in both cases the seasonal trend is observed.

According to the seismic catalogue data of Geophysical Survey of the RAS five relatively strong earthquakes ($K > 9.5$) occurred in the considered time interval in the area with coordinates 42.5–42.75°N, 74.5–75.00° E. Almost all earthquakes within the Bishkek test site occurred at depths of 5–15 km. Epicenter of the event on 12.02.2013 (42.69°N, 74.865°E, $K=9.65$) was located about 2 km away from the Shamsi fault (the moment of the earthquake is marked by an arrow in Fig. 2). Measurement sessions at the KENTOR site were conducted on 07 and 14.02.2013. Local maxima in Fig. 2, *a* refer to the measurements on 14.02.2013 г. Lines from group II that do not cross the fault have no changes at that time (see Fig. 2, *b*).

Measurement sessions for another three events of 2013 were badly positioned in time relative to the seismic events. So, the earthquake on 29.07.2013 (42.678°N, 74.815° E, $K=9.62$) occurred 5 days after the measurement session (24.07.2013) and 8 days before the next one (06.08.2013).

The earthquake on 17.10.2013 (42.633°N, 74.975° E, $K=10.59$) occurred 8 days after the measurement session on 09.10.2013 and 7 days before the session on 24.10.2013.

The third event (26.12.2013, 42.616° N, 74.947° E, $K=9.72$) happened one day after one session and 14 days before the next session on 09.01.2014.

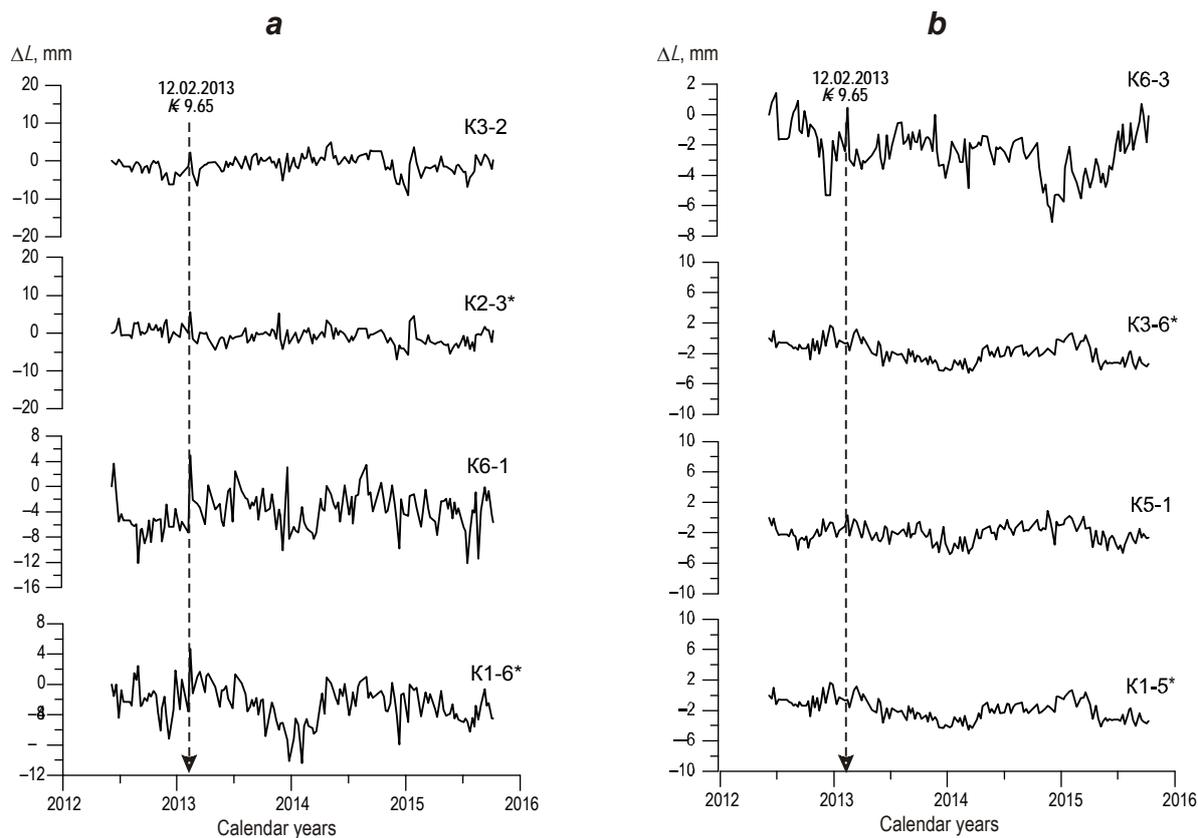


Fig. 2. The KENTOR site. Length variations of the lines relative to its first value for (a) group I and (b) group II for direct and reverse measurements. Here and below, the numbers of lines for the direct course are marked as star; the vertical arrow in all figures is a moment of the event 12.02.2013.

The noted refers also to the sites POLIGON and ALMALY, since the measurement sessions are shifted only for a day relative to the measurements at the KENTOR site. Only the earthquake on 08.04.2015 (42.541°N, 74.503°E, $K=10.2$) successfully happened between measurement sessions, but in the present work variation analysis in comparison with this event could not be given. This is due to the fact that the focus of the event on 08.04.2015 is located at a considerable distance (~ 30 km) from the sites and, moreover, at the moment of writing this work, the results of *GPS* measurements necessary for the comparison with the results of optical range finding observations have not yet been processed.

Length variations of the lines P0-02 and P0-03 from group I at the site POLIGON for the direct and reverse course are given in Fig. 3, a, length variations of the lines from group II – in Fig. 3, b. Comparison of these Figures leads to the conclusion that unlike the KENTOR site (see Fig. 2), amplitude of oscillations on the lines of different groups is approximately the same. Note that the epicenter of the earthquake on 12.02.2013 was 14.3 km away from the POLIGON site and 8.2 km away from the KENTOR site.

Visual examination of the plots given in Fig. 2, 3, and analysis of length variations of all other lines including from the ALMALY site, allow us to assume that during several days before or after the earthquake on 12.02.2013 at the KENTOR site the lines crossing the Shamsi fault were extended. This is clearly manifested in the appearance of synchronous maxima on the plots for the lines K1-6*, K6-1, K2-3*, K3-2 (see Fig. 2, a).

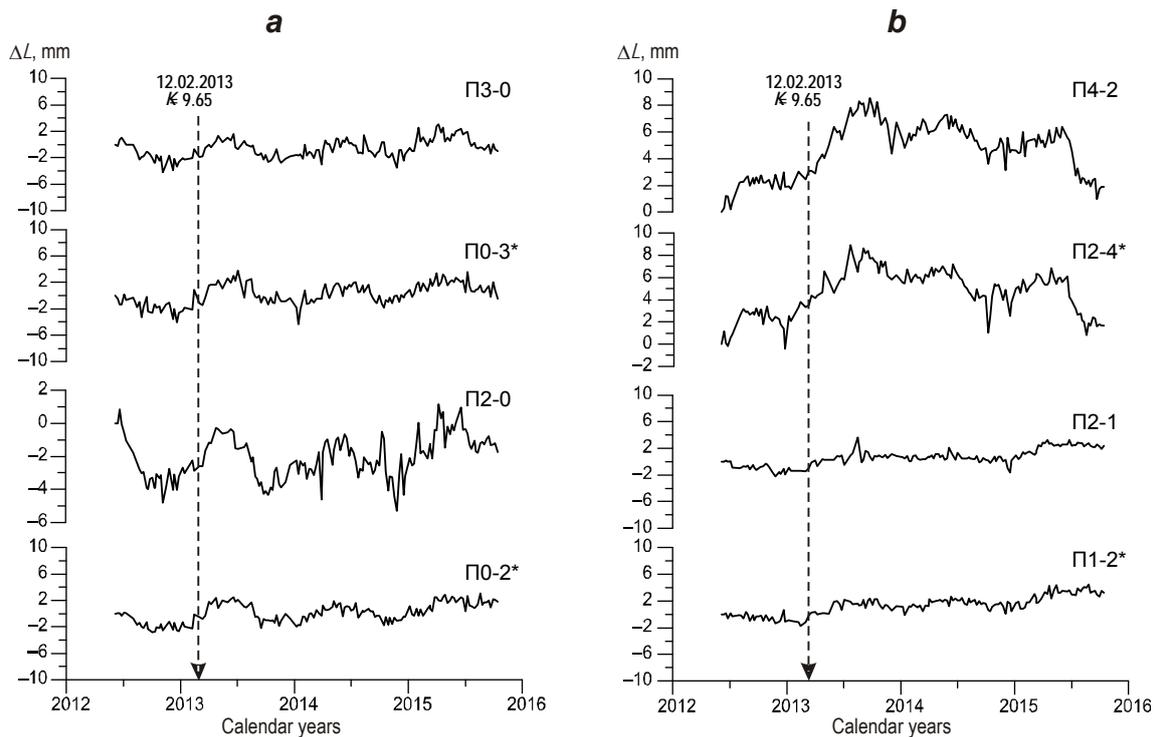


Fig. 3. The POLIGON site. Length variations of the lines relative to its first value for (a) group I and (b) group II for direct and reverse measurements. Here and below, the numbers value for (a) group I and (b) group II for direct and reverse measurements.

Low-frequency variations complicate the comparison of data on different lines, so for the further analysis differences of consequent in time references were constructed. This eliminated seasonal trends.

Plot I in Fig. 4 represents the averaged difference of lines K1-6, K5-6, K2-6, K2-3 (group I) crossing the Shamsi fault at the KENTOR site (see Fig. 1) for direct and reverse measurements. There stands out an anomaly with amplitude exceeding three standard deviations (3σ). According to the various criteria for assessing the significance of emissions [Kobzar, 2006], the nonrandomness of its occurrence is more than 0.99. Measurements on 14.02.2013 showed that compared to 07.02.2013 the length of lines on the average increased by 7.8 mm. The next measurement on 21.02.2013 showed that the length decreased by 11.2 mm in comparison to the measurement on 14.02.2013. It can be concluded from the comparison with the background level that the reaction time for the event of 12.02.2013 did not exceed several days (3–8 days).

Similar difference curves for four lines (8 measurements) were calculated for the sites POLIGON and ALMALY (plots 3-6 in Fig. 4). When considering the obtained plots, no significant anomalous changes were detected. Dashed lines near the corresponding graphs indicate the levels of 3σ , showing that the largest amplitude of oscillations is typical for the KENTOR site, and the smallest – for the ALMALY site. The latter is associated, apparently, with the fact that the trace of the Shamsi fault is not crossing the ALMALY site.

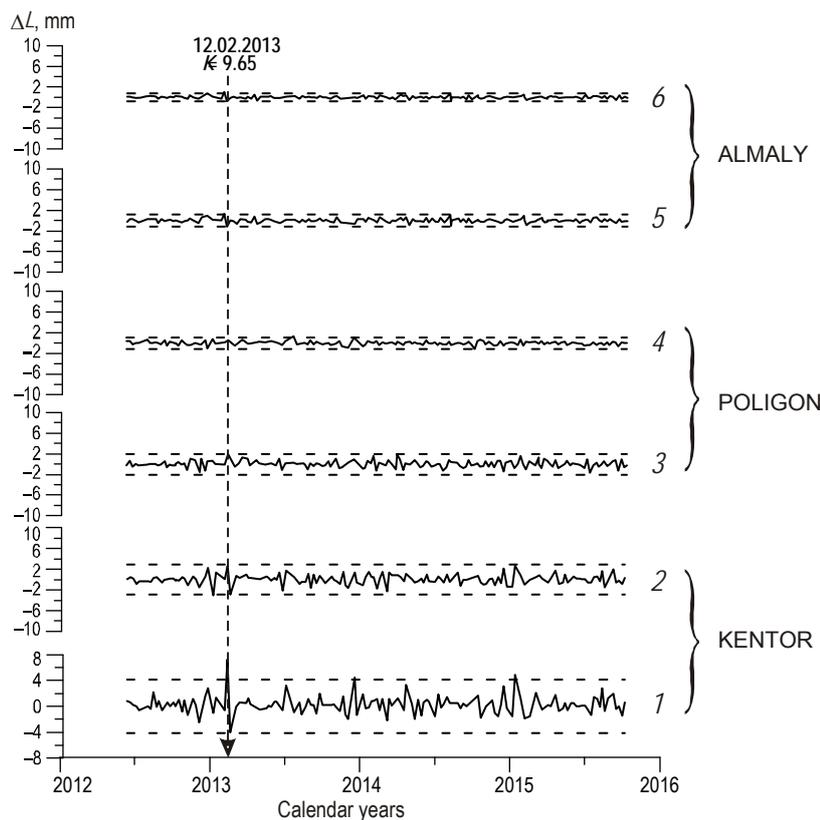


Fig. 4. Variations in the averaged difference between the consequent measurements of the line length crossing (group I) and not crossing (group II) the Shamsi fault at (1, 2) KENTOR, (3, 4) POLIGON sites and (5, 6) lines of submeridional and sublatitudinal orientation at the ALMALY site. Dashed lines are borders $\pm 3\sigma$

Movement variations of GPS stations

GPS observations conducted at the Bishkek test site enable to estimate whether the movement variations of GPS stations were detected during the period of observation of optical range finding anomaly on 02–14.02.2013. Three of the mentioned stations (see Fig. 1) – *IATA*, *IAT3*, *POL2*– are located to the south of the Shamsi-fault, *CHUM* is located to the north of it (coordinates of the stations and height above sea level are given in Table 2).

Table 2. Geographical coordinates and height above sea level of GPS stations, located on the territory of the Bishkek geodynamic test site

No.	GPS stations	φ° N	λ° E	H , m
1	<i>IATA</i>	42.653	74.841	1911.79
2	<i>IAT3</i>	42.660	74.850	1785.57
3	<i>POL2</i>	42.680	74.694	1714.20
4	<i>CHUM</i>	42.998	74.751	716.32

GPS data were analyzed for the period from 05.06.2012 (the beginning of the described optical range finding observations) to 31.12.2014 (the later data were not processed at the moment of writing this paper). 239 observation sessions were performed at the stations *POL2* and *CHUM* during this time interval; stations *IATA* and *IAT3* were missing some sessions that were filled using the linear interpolation. Displacement variations of stations (1) *IATA*, (2) *IAT3*, (3) *POL2*, (4) *CHUM* vertically (ΔH) are presented in Fig. 5.

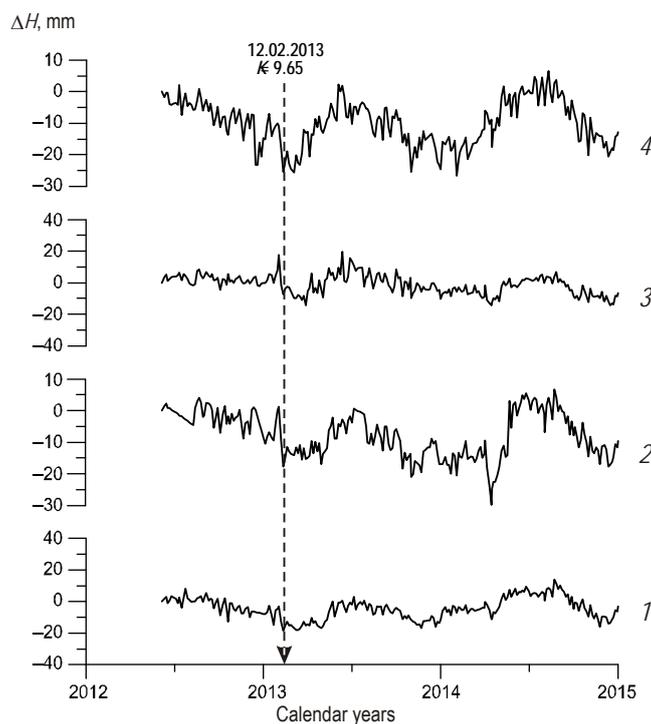


Fig. 5. Position variations of the stations (1) *IATA*, (2) *IAT3*, (3) *POL2*, (4) *CHUM* in height (ΔH) relative to the value of the first measurement

In the period of 02–11.02.2013 all stations had a decrease in height by 15–25 mm. Observation session on 15.02.2013 detected the reverse change towards the relative increase in height. Synchronicity of changes means that the observed changes are not random.

To some extent, the result is confirmed by the data given in Fig. 6, *a*: alongside a trend shift of stations to the north, the decrease of the movement velocity is also seen in the time interval 02–11.02.13, i.e. before the earthquake which is marked with arrows in Figures. On the east-west components (Fig. 6, *b*) changes in this interval are within the noise level.

Data interpretation

As it was already noted, stations *IATA*, *IAT3* and *POL2* are situated to the south of the Shamsi fault; station *CHUM*, to the north of it (see Fig. 1). Stations are located several kilometers away from each other. Decrease of height (see Fig. 5) and slowing-down of the movement to the east (see Fig. 6, *a*) were observed simultaneously for all *GPS* stations. Moreover, difference in displacement amplitudes was at the level of measurement error. This indicates that synchronous anomalous movements were equally manifested in the study area of the Bishkek geodynamic test site.

What can cause such a phenomenon and, first of all, the lowering of the territory during the period from 2 to 11 February 2013? One of the possible reasons is an abnormally high atmospheric pressure. This assumption was tested using the data of meteorological station located in 650 m from *IATA* and *IAT3*. Diagram 1 in Fig. 7 shows pressure variations for the period 1.12.2012–14.03.2013¹.

¹In general, low values of atmospheric pressure are explained by the location of weather station at the height of ~1900 m above sea level.

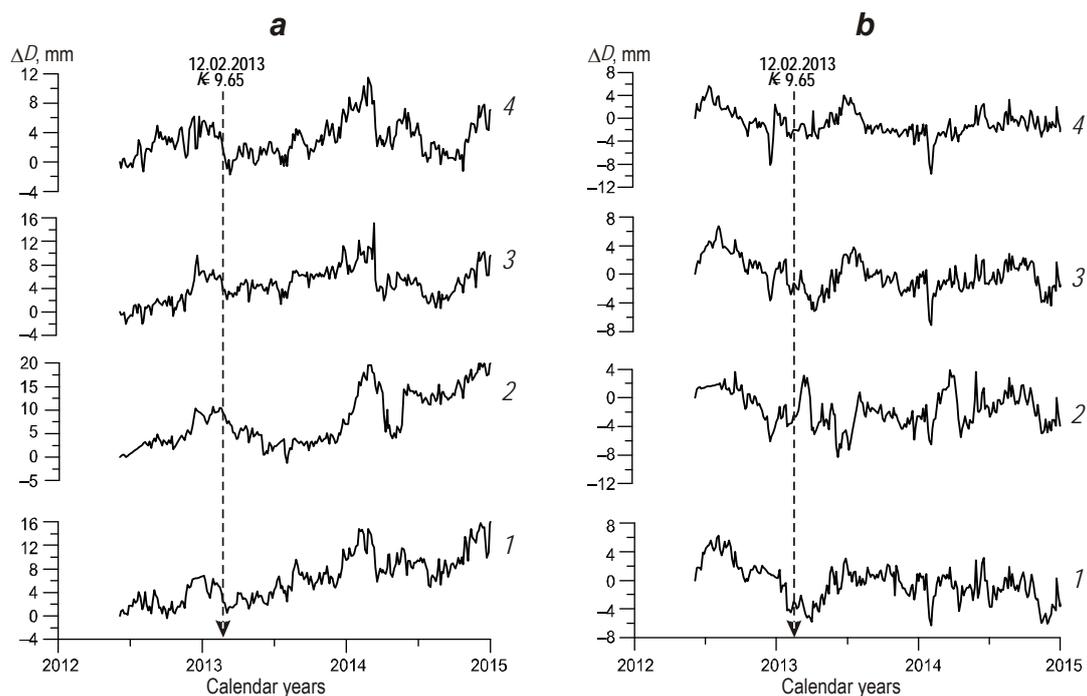


Fig. 6. Displacement variations of the stations (1) IATA, (2) IAT3, (3) POL2, (4) CHUM in the direction (a) “north-south” and (b) “east-west”

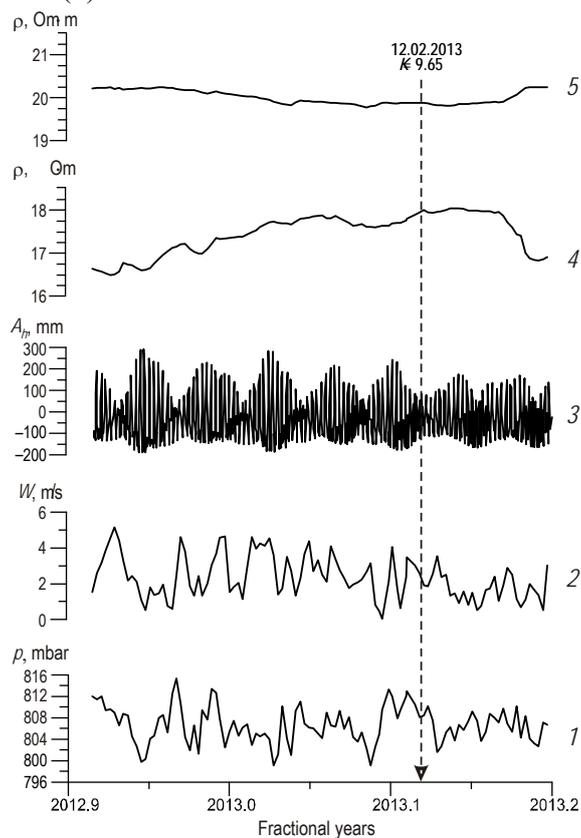


Fig. 7. Variations of (1) atmospheric pressure p , mbar, (2) wind speed W , m/s, (3) vertical component of the earth tide A_{h_3} , mm and (4, 5) electrical resistivity in the Earth’s crust ρ , Om-m (4 is component E–W, 5 is N–S) defined by sounding data at TB station. The arrow marks the date of the earthquake, 12.02.2013.

Anomalous changes in pressure were not detected in the period before and after the earthquake on 12.02.2013. In diagram 2 of Fig. 7 are shown wind speed variations; this parameter also indicates good meteorological conditions. Note, that air temperature was stable in the range from -2 to -5 °C.

Second natural factor that influenced the surface deformations were earth tides. Variations of vertical and horizontal components of the tide were calculated using *TIDEN* program [Wenzel, 1995]. Vertical deformations of the tide can cause a temporary lowering of the territory. But there are no abnormal features during the earthquake in the diagram of their variations (diagram 3 in Fig. 7).

Let's look at the results of deep electromagnetic sounding performed by the method of field formation. Variations of electrical resistivity were measured on the network of stations with mutually perpendicular electric dipoles that receive electromagnetic signals from transmitting dipole situated in the central part of geodynamic test site. Since 1982 the electromagnetic observations at the Bishkek test site are conducted every day that resulted in a vast experience in its application [Trapeznikov, Volykhin, Bragin, 1986; Trapeznikov et al., 1989]. Nowadays, a method of field formation in the far zone is used. Monitoring observations are carried out at different time intervals of formation of the medium transient characteristics; measurement accuracy of variations is not worse than 1%. One of the *TB* receiving stations is located at the KENTOR site at a distance of 5 km from the Shamsi fault (see Fig. 1, *TB* station).

Measurements allow estimation of ρ variations at different depths. For *TB* station they are almost identical in the depth range from 1 to 15 km with correlation coefficients >95 %. Diagrams 4 and 5 in Fig. 7 represent ρ variations at the depth of approximately 10 km in components N-S and E-W. Analysis was conducted at times of field formation of 0.86 s. Earlier [Fridman et al., 2005] it was established that in some cases variations of ρ at this station were significantly correlated with deformations of the Earth's crust traced by *GPS* data. In our case, there were no abnormal changes during the earthquake on 12.02.2013. Electrical resistivity of the rocks in the Earth's crust depends on water saturation of cracks and intra porous pressure. Absence of significant changes of ρ during 2–11.02.2013 indicates that lowering of the Earth's surface noted in *GPS* variations did not affect these rock properties, i.e. the massif was deformed as a whole.

The above data (see Fig. 7) indicates that variations of atmospheric pressure, amplitude of the earth tide and electrical resistivity of rocks were not the cause of deformations revealed by *GPS* method. In this regard, the passing of hypothetical deformation wave is not excluded. It would be possible to clarify this question by analyzing deformations at the adjacent territories to the Bishkek test site. However, regular observations with discreteness of about a week or less were not carried out on them.

Returning to Fig. 2 and diagram 1 in Fig. 4, note that change of line length at the KENTOR site in the interval between measurement sessions on 07 and 14.02.2013 falls out of the idea of uniform deformations of the Bishkek test site surface according to *GPS* data. Highly significant changes were found only on the lines crossing the trace of the Shamsi fault. These submeridional oriented lines are located almost perpendicular to the fault trace near the KENTOR site. Abnormal changes were not detected on the lines of the same direction at the ALAMLY site not crossing the fault (diagram 5 and 6 in Fig. 4). It is logical to assume, that the extension of the lines at the KENTOR site is caused by the local deformation of the tension in the fault zone.

It can be considered a fixed fact, that horizontal and vertical deformations in fault zones exceed deformations in the surrounding rock massif in many times [Kuzmin, 2004], i.e.

localization of deformations is manifested which is due to the different rigidity of the fault material and rock massif.

Spivak [2011] estimated the value of the normal rigidity of different fault zones as $k_n = d\sigma_n/dW_n$ (MPa/mm), where $d\sigma_n$ is a normal mechanical (tectonic) stress acting on the fault walls; dW_n is a normal displacement of the walls. Also he showed that rigidity changes depending on the length of the fault zone L according to the formula $k_n = 3/L^{0.55}$.

Assuming that the length of relatively straight part of the Shamsi fault near the KENTOR site is 10 km, we obtain the estimation of its normal rigidity $k_n \approx 0.85$ MPa/mm. Estimations of rigidity value were performed with seismic loads on the fault zones. However, *Kocharyan* and *Spivak* [2003] showed that rigidity varies little with substantially different period of dynamic load acting perpendicular to the fault. It gives grounds for using the above equations in estimation calculations in our measurements carried out with periodicity of several days.

The fault can be likened to the membrane if it is filled with a relatively softer material compared to the surrounding rocks. Devices like disks filled with liquid and placed in cracks allow to measure variations of stress in the massif perpendicular to the disk plane [*Shporkin, Sobolev*, 1981, 1983]. Relative displacements of membrane walls with the ratio of its diameter to thickness $D/W > 20$ are in direct proportion to mechanical stress changes perpendicular to the membrane plane. It gives an opportunity to estimate variations of tectonic stresses acting on the fault according to the data of the width change of the fault zone.

It was shown above (see Fig. 2, 6), that baselines of distance measurements crossing the Shamsi fault at the KENTOR site increased by 7.8 mm during February 2 and 14, 2013. All deformation can be related to the fault zone filled with the material softer than the surrounding massif. Taking into account the explanations in two previous paragraphs we come to the following conclusion. During the earthquake on 12.02.2013 ($K=9.65$), apparently, there was a fluctuation of the normal stresses acting on the Shams fault $d\sigma_n = k_n dW_n = 6.6$ MPa. Considering, that the given formulas of fault rigidity were obtained from empirical data and cannot be absolutely accurate, in our case we take $d\sigma_n \approx 7$ MPa.

We cannot say whether the shift in the Shamsi-fault zone occurred before or after the earthquake of 12.02.2013, as consequent sessions of distance measurements at the KENTOR site were performed on 07 and 14.02.2013. But it is known, that abnormal changes in the movement velocity of the upper layers of the Earth's crust at the Bishkek test site were detected by *GPS* data in the period between 7 and 11 of February, i.e. before the earthquake on February 12.

Earthquake focal mechanisms are studied in this area on a regular basis [*Sychev, Yunga*, 2011]. According to the focal mechanism of the earthquake on 12.02.2013 (see Fig. 1), it follows that maximum compression axis was oriented submeridionally (174°) and had an angle of the dip close to horizontal (3°). Axis of the maximum tensile stresses was oriented in sublatitudinal direction (265°) with a small angle of the dip (11°). Accordingly, both possible planes of the slip were directed approximately at an angle of 50° to the trace of the Shamsi fault and had a subvertical dip.

Dynamic parameters of the earthquake were estimated according to the records of stations located near the source (≤ 60 km), using the method of *Sychev and Bogomolov* [2014]. Taking into account errors in determination of energy and a number of dynamic characteristics we take the following parameters of the discussed earthquake: energetic class is $K \approx 9.5$, seismic moment is $M_0 \approx 4^{12}$ J·m, length of the slip is $U < 3$ mm, dropped stress is $\sigma \approx 0.6$ MPa. We can certainly assume that such an earthquake could not cause the expansion of the Shamsi fault by 7.8 mm and change of subhorizontal stresses on its sides of ≈ 7 MPa. Consequently, it is more likely that the change of geodynamic situation contributed to the occurrence of the earthquake, and not vice versa.

Conclusions

Registration of a complex of geophysical parameters at a number of points of the Bishkek test site of the RAS Scientific Station enabled to estimate geodynamic situation during the local earthquake of energetic class $K=10$ that occurred on 12.02.2013.

According to *GPS* observations a few days before the earthquake on the territory of the test site was detected lowering of the Earth's surface with amplitude of ~ 20 mm.

Based on the results of optical range finding measurements, width increase by approximately 8 mm of tectonic fault (2 km away from the epicenter) was established during several days in the period of an earthquake. Such change in fault width corresponds with the change in the acting tectonic stresses in its area approximately by 7 MPa. It is obvious that the established change of geodynamic situation could contribute to the occurrence of the local earthquake.

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