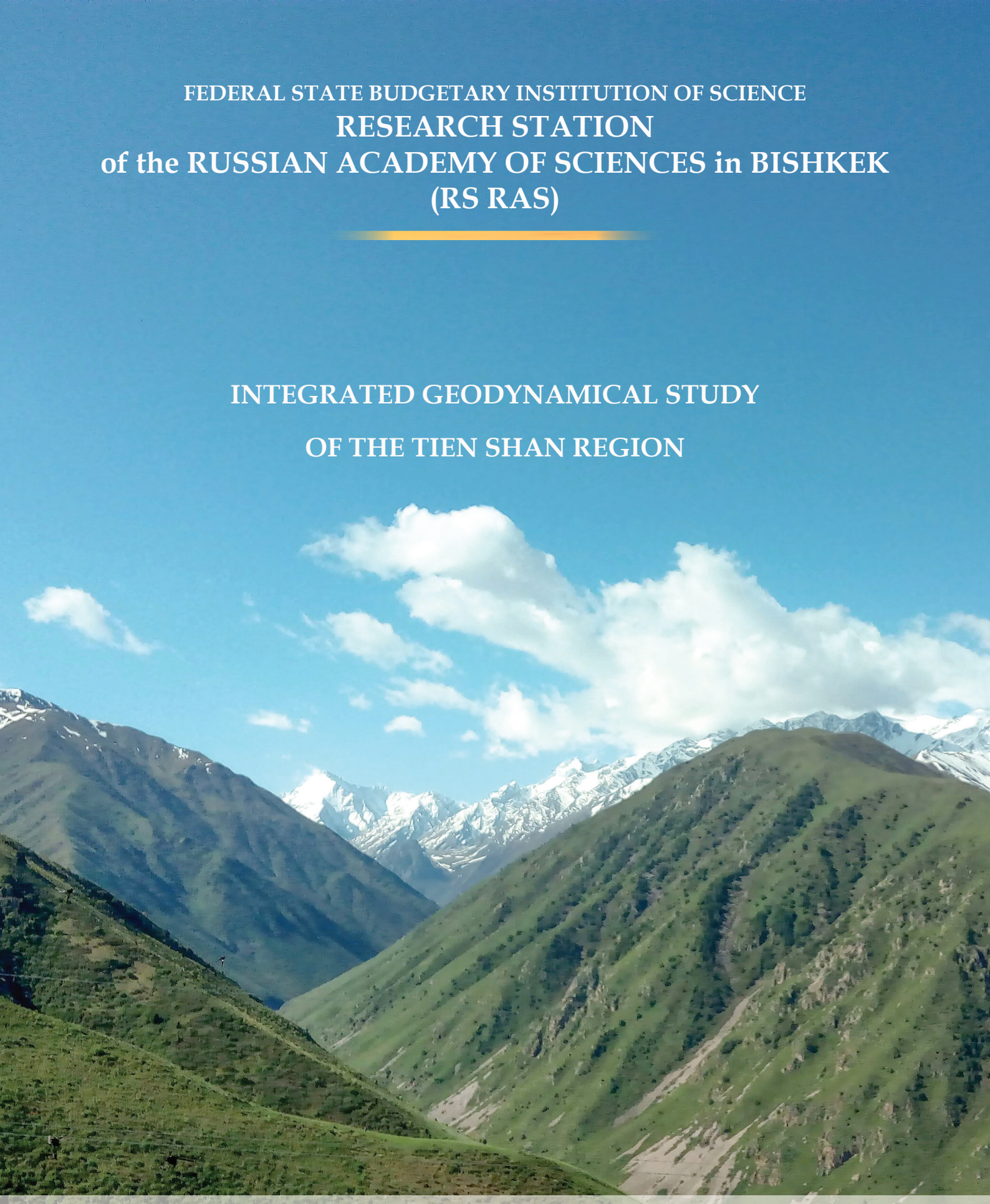
FEDERAL STATE BUDGETARY INSTITUTION OF SCIENCE

RESEARCH STATION of the RUSSIAN ACADEMY OF SCIENCES in BISHKEK (RS RAS)

INTEGRATED GEODYNAMICAL STUDY OF THE TIEN SHAN REGION



НС РАН г.Бишкек

LEGAL STATUS OF RS RAS

• The RS RAS has the status of Institute of Earth's Sciences Department of the Russian Academy of Sciences.

• The RS RAS carries out its activity on the territory of the Kyrgyz Republic on the grounds of Protocol signed by the Government of Russian Federation and the Government of Kyrgyz Republic on December 31 1997, "About the legal and property status of the Research Station and the Test Survey Expedition of the Joint Institute of High Temperatures of the Russian Academy of Sciences in Bishkek" and the Agreements between the Government of the Russian Federation and the Government of the Kyrgyz Republic on introduction of amendments to the Protocol between the Government of Russian Federation and the Government of Kyrgyz Republic of 31 December 1997. "About the legal and property status of the Research Station and the Test Survey Electromagnetic Expedition of the Joint Institute of High Temperatures of the Russian Academy of Sciences in Bishkek city" of 23 July 2007.

• Since 25 January 2012, the Research Station of the Russian Academy of Sciences in Bishkek city has been renamed into Federal State Budgetary Institution of Science the Research Station of the Russian Academy of Sciences in Bishkek city (RS RAS) on the grounds of RAS Presidium Resolution No. 262 of 13 December, 2011.

• According to the Federal Act No. 253-FZ of 27 September 2013, "About the Russian Academy of Sciences, reorganization of State Academies of Sciences and introduction of amendments to certain acts of the Russian Federation" and the Order of the Government of the Russian Federation No. 2591-r of 30 December,2013, the RS RAS was transferred under the jurisdiction of the Federal Agency of Scientific Organizations (FASO of Russia), under the number 155 according to the List of the organizations subordinated to FASO of Russia.

• According to the Decree of the President of the Russian Federation No. 215 of 15 May 2018, the RS RAS was transferred under the jurisdiction of the Ministry of Science and Higher Education of the Russian Federation.

• Russian Federarion is the founder and owner of RS RAS property.

RS RAS GOALS AND ACTIVITIES

The RS RAS main goal is the conducting fundamental and applied researches in area of Geodynamics.

The objects of RS RAS activity are as following:

- Study of Earth's physical fields, their nature and interaction.
- Study of Earth's deep structure and geodynamics, interaction of internal and external (hydrosphere, atmosphere, ionosphere) geospheres.
- Development of data bases and banks of geological and geophysical data.
- Study of modern movements and monitoring of nature state, exploration of seismicity, assessment of nature and technogenic disasters risks.

HISTORY OF THE GEODYNAMICAL PROVING GROUND ESTABLISHMENT IN THE MOUNTAINS OF KYRGYZ TIEN SHAN

At the end of 70's the problem of development and experimental testing the method of strong earthquakes prediction using MHD generator was set before the Institute of High Temperatures of the Soviet Union Academy of Sciences. Solving this task, Research Station began organization of Experimental Proving Ground in Kyrgyzstan and Uzbekistan . The research results of Institute of the Earth's Physics, USSR Academy of Sciences at the Garm test-area in Tadjikistan became the basis for establishment of Experimental Proving Ground where MHD-generators was used. The correlation between changes of rock electrical resistance and local seismicity was revealed here for the first time.

In 1978 the Presidium of USSR Academy of Sciences took a decision about the organization of Research Station of the Institute of High Temperatures of the USSR Academy of Sciences in Frunze city (Kyrgyzstan) for execution of experimental and methodical works on development of techniques for earthquake prediction applying MHD-generators. This decision was declared by the Directive №076 of 17 April, 1978, of Presidium of the USSR Academy of Sciences. And, at last, in pursuance of Directive of the USSR Academy of Sciences Presidium the decision was taken to allow Institute of High Temperatures for establishing the Research Station in Frunze city.

The Research Station was assigned to perform the following tasks:

- development of a system for electromagnetic field components automatic recording in the Earth's crust and a system for telemetric data transmission to collection and processing centers;
- development of algorithms for registered signals processing;
- testing the method of deep electromagnetic soundings based on MHD - genetators;
- establishing of correlations of changes in electrophysical parameters of the Earth's crust deep layers with data of seismological observations.

Vladimir A. Zeigarnik and Yuri A. Trapeznikov were the first organizers and executive performers of all works on establishment and construction of Prognosis Geophysical Proving Ground in Frunze city.

In February, 1982, according to the Decree of the USSR Academy of Sciences Presidium, the Experimental Methodical Electromagnetic Expedition of the Institute of High Temperatures (EMEE RS RAS) was organized as an independent department in the structure of the Scientific Association RS RAS.

The task of multidisciplinary geologic and geophysical experiments realization in a context of prediction research area and its support with modern methods of measurement and processing of observation was assigned to the EMEE RS RAS.

Yuri Andreevich Trapeznikov was appointed as a Director of newly - formed Geophysical Proving Ground. To our regret, he untimely deceased in 1999.

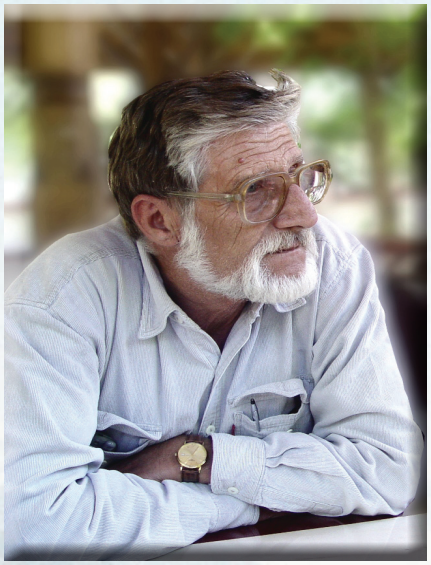
Contemporary views about the nature and development of seismic process, obtained in the course of this task performance, have shown the need to move from the analysis of formal statistics of earthquakes and phenomenological observations to the study of deep environmental heterogeneities of seismic region and construction of well-founded geodynamic models of various scales. Confidence in the rationality of this approach to solving the seismic prediction problem had been stipulated by the results of multy-year research conducted by the staff of the Research Station and Experimental Methodical Electromagnetic Expedition in the Tien Shan mountains.

The experimental data accumulation and the first results of their interpretation set the task of strengthening the scientific component of research, associated primarily with a comprehensive interpretation of constantly growing database of geological and geophysical data characterizing the development of deformation processes in the Tien Shan region. This required some changes in the organizational structure of the Experimental Methodical Electromagnetic Expedition and the Research station. As a result, there was a merger and formation of a new unified structure represented by the Research Station of Joint Institute of High Temperatures of the Russian Academy of Sciences (RS JIHT RAS).

Need in large-scale comprehensive observations was revealed in consequence of detailed study of the territory of Bishkek Geodynamical Poligon deep structure by means of electromagnetic soundings. The artificial sources of current were applied, what allowed discovery a number of unknown earlier structural elements playing an essential role in formation of seismogenerating objects. First of all, this applies to crust bearing horizons and to some features of their structure defining seismicity. Therefore, the problem of universality of such tectonics for other Tien Shan seismogenerating zones had been raised. Thus, the vector of a geophysical complex study turned to the plane of region modern geodynamics study.

RS RAS ADMINISTRATION

Anatoly RYBIN
Director, Dr. of Physics and Math



Gennady SCHElOCHKOV
Head of Representative Office in RF

Olga ZABINYAKOVA
Academic Secretary

Sergei DRUZHINETS
Vice-director

MAIN AREAS OF RS RAS RESEARCH

- Physical fields, internal structure of the Earth and deep geodynamic processes.
- Catastrophic endogenous and exogenous processes, including extreme changes of space weather: problems of forecast and decline of negative effects.
- Scientific basics of development of methods, technologies and facilities of the Earth's surface, subsoil and atmosphere investigation, including the Earth's ionosphere and magnetosphere, hydrospheres and cryospheres.
- Computational modeling and informatics: infrastructure of spatial data and GIS-technology.

RS RAS LABORATORIES

Research laboratories and groups are the main scientific RS RAS subdivisions. When required, the temporal research teams are formed in order to execute the specific projects, state tasks or programs.

Laboratory of Integrated Studies of Geodynamic Processes in Geophysical Fields (LIS)

The main objective of LIS is a complex study of dynamic processes observed in various geophysical fields (in the first turn in electromagnetic ones), their connection with specific tectonic structures and deformation processes which stipulate seismic regime on the Bishkek Geodynamic Polygon's territory.

The Laboratory of Deep Magnetotelluric Studies (LDMS)

The main objective of LDMS is the research of structure and dynamics of electrical properties of the Tien Shan region lithosphere at various spatial-temporal scale levels, determined by complex deep electromagnetic soundings (MTS-MVS) results.

Laboratory of Studying Modern Movements of the Earth's Crust by Space Geodesy (LGPS)






The main activity of LGPS is aimed at modern movements of the Earth's crust and associated geodynamic processes study using ground and space geodesy methods in the Central Asian region. The laboratory is engaged in a comprehensive interpretation of geodetic and seismic data with use of results from related Earth sciences, estimation of accuracy of applied geodetic measurements methods, improvement of data obtaining methodology, application of advanced technologies and development of new approaches to data analysis.

Laboratory of Energy-Saturated Media Simulation (LESMS)


The main objective of LESMS is developing the physical model of energy transformation processes in earthquake source, synthesizing both the latest geophysical and geodynamic achievements, as well as new results of solid state physics and fracture mechanics. Development of such model and building-up of experimental data on action of physical fields at different stages of deformation process is of great importance for the prospects of scientific and practical use of these fields.

Laboratory of Advanced Hardware Development (LAHD)

The main activity of LAHD is aimed to development and introduction of original specialized electronic equipment. The equipment was designed to function as a part of system of active electromagnetic monitoring of stress-strain state of the Earth's crust existing on the Bishkek Geodynamic Polygon.

PUBLISHING ACTIVITY OF RS RAS

During the entire period of RS RAS functioning, the Research Station staff have published results of their research in such foreign journals as "Nature", "Gondwana Research", "Geophysical Research Letters", "Geological Society of London", "Journal of Asian Earth Sciences", "Journal of Geophysical Research", "Geophysical Journal International", "Acta Geodetica et Geophysica Hungarica", "Tectonophysics", "Tectonics", etc., as well as in peer-reviewed journals such as «Physics of the Earth», «Geology and Geophysics» , «Notes of the Mining Institute», «Geotectonics», «Lithosphere», «Geophysical Research», etc. Three collective monographs were published:
1. MANIFESTATION OF GEODYNAMIC PROCESSES IN GEOPHYSICAL FIELDS. Ed. E.P. Velikhov and V.A. Zeigarnik. Moscow: Nauka, 1993. 158 P.
2. MODERN GEODYNAMICS OF INTRACONTINENTAL AREAS OF COLLISION MOUNTAIN BUILDING (CENTRAL ASIA). M .: Scientific World, 2005. 400 P. / Ed. V.I. Makarov.
3. GISSARO ALAY AND PAMIR – Comparative Tectonics and Geodynamics. The team of authors: Head of the Laboratory of Tectonics of Consolidated Crust of GIN RAS, Dr. M.G. Leonov; Director RS RAS, Dr. A.K. Rybin, RS RAS leading scientist: Dr. V.Yu. Batalev, Ph.D. E.A. Bataleva, Ph.D. V.E. Matyukov, Head of the Representative Office of RS RAS in the Russian Federation G.G. Schelochkov. Additionally, the monography was published: Rybin A.K., DEEP STRUCTURE AND RECENT GEODYNAMICS OF THE CENTRA TIEN SHAN BY MAGNETOTELLURIC RESEARCH RESULTS. - M.: Scientific World, 2011. 232 P.

NETWORK OF COMPLEX GEODYNAMIC OBSERVATIONS OF RS RAS

Network of digital broadband telemetric seismological stations (KNET) consist of 10 PASCAL stations and 3 repeaters. For measurements, the STRECKEISEN STS-2 sensors with REFTEK72-6 registrars are used, which ensure the registration of seismic signal in a large dynamic range (140 dB) and in a broad frequency band (0.008 - 50 Hz). Modern telemetry equipment and data processing procedures allow obtaining the network data, as well as the results of their express processing in real time mode. KNET network's digital data is transmitted to partner organizations (Institute of Seismology of Kyrgyzstan, Institute of Geophysical Research of the Republic of Kazakhstan) via Internet channels.

The first sites of the Central Asian GPS network were established in 1992, and after 25 years of their operating, the database of RS RAS contains information on 720 measurement sites. This network is one of the largest in the world in class of GPS systems of regional scale. GPS observation sites are distributed over area of ~ 2 million square kilometers in the territory of 5 states: Kyrgyzstan (363), Kazakhstan (187), Uzbekistan (35), Tajikistan (42) and China (94). From them, the frequency of recording information from satellites at 17 stationary sites are taken with 30 seconds. To the north of Bishkek, in the foothills of the Kyrghyz mountain range, the local network has been operating since 1997. It currently consist of 45 sites, each of which is measured during 36 hours 4 times a year. The rest of sites belong to the category of regional ones and are still subject to measurement (except for the territories of Kazakhstan and Uzbekistan) no more than once (36 hours) during 1-3 years.

The system of geomagnetic observations consists of 7 stationary sites equipped with modular magnetovariational proton stations of MB-07 type. The sensitivity of these stations is 0.01 nT with a mean square error of 0.02nT. Observations are made with a discreteness of 20 seconds.

The system of electromagnetic monitoring by the method of time-domain electromagnetic (tdem) sounding is applied at 6 stationary sites with a frequency of measurements 5 times a day and 17 visited sites with a frequency of measurements no less than 2-3 days. ERGU-600-2 electropulse system is applied as the generating unit for carrying out deep soundings. This system is powered by the industrial electrical network (400 V) and provides alternating current of certain shape in the generator circuit from 50 to 1200 A, depending on the problem to be solved. With standard sounding, a sequence of polar rectangular pulses of amplitude 600A and a period of 10 seconds is used. In Bishkek Polygon conditions this sistem allows obtaining information about dynamic processes in the Earth's crust up to 30 km depths. As the receiving stations the electrometric stations of the IS type are used.

System of profile magnetotelluric and magnetovariational soundings: approximately 800 session of soundings were carried out in a wide frequency range - along seven regional profiles of the submeridionally secant Tien Shan orogen and a series of short detail profiles. Field measurements of the components of the Earth's own electromagnetic field in these studies were carried out using various equipment: MT-PIC, LIMS and EMI MT-24, Phoenix MTU-5. During the period 1982-1999. sounding were carried out by domestic measuring stations TsES-2 and IZMIRAN-5.

THE MOST IMPORTANT SCIENTIFIC RESULTS

1. In 2015 - 2016, a small-sized, thermostable induction sensor was developed. It has high sensitivity and provides measurement of magnetic induction in the frequency range from 0.1 Hz to 80 kHz (figure 1). The novelty of this development is significantly increased constant integration while maintaining high temperature stability of sensor conversion coefficient. The model sample of sensor was made. The developed sensor can be used in any electrical equipment based on artificial and natural electromagnetic fields measurement.

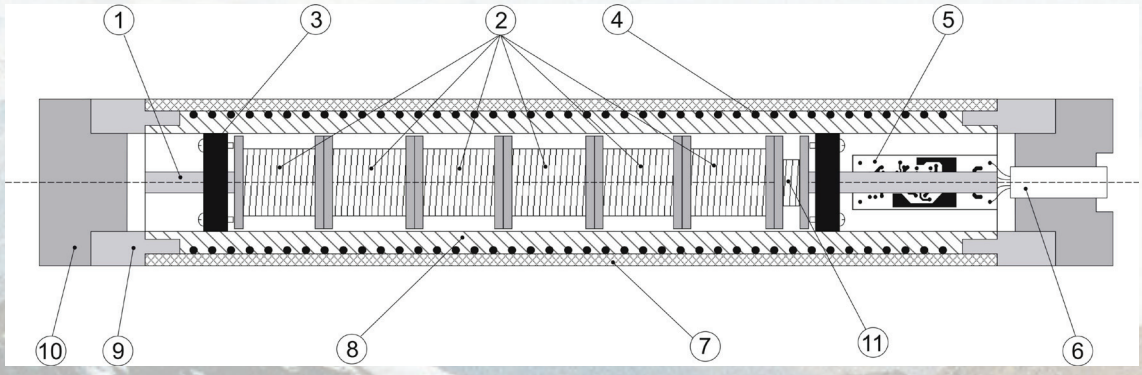


Figure 1 – design of induction sensor: 1 – ferromagnetic core; 2 – section of measuring coil; 3 – rubber seal (shock); 4 – calibration coil, 5 – preamplifier; 6 – connector; 7 – layout; 8 – internal housing (screen); 9 – locking cylinder; 10 – stopper; 11 – additional compensation coil.

In 2017, new model sample of the electrical measuring system with pseudo noise signals (EMS/PNS), characterized by increased technical characteristics and parameters, was designed and manufactured (Fig. 2). The results of laboratory experiment to measure the output signal-to-noise ratio for the previously manufactured and new prototype EMS/PNS showed an increase of 22 dB (12.6 times) of this ratio for the new layout EMS/PNS compared with the previously manufactured. The measuring complex of EMS/PNS is planned to be used for electromagnetic monitoring of stress-strain state of the Earth's crust at Bishkek Geodynamic Polygon measuring points.

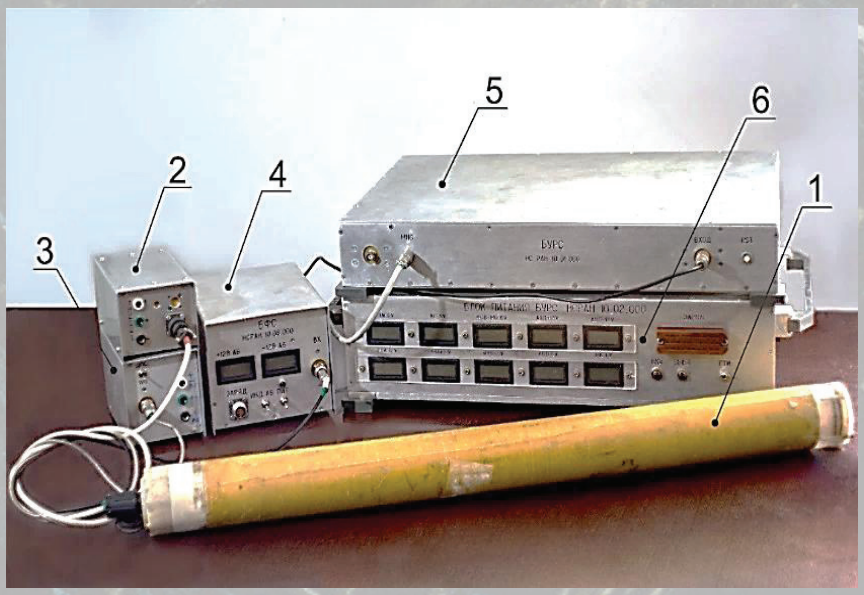


Figure 2-Appearance of measuring channel of new model sample EMS/PNS:
1-induction signal sensor; 2 -power supply of induction signal sensor; 3-calibration signal generator; 4-signal filtering unit; 5-control and signal registration unit; 6-power supply of control and signal registration unit

Authors: Il'ichev P.V., Bobrovsky V.V., Lashin O.A., Lisimov M.O.

2. Applying the correlation analysis of time and frequency sequence of electromagnetic parameters the indicative strain-sensitive elements of geo-environment that correspond to the zones of dynamic influence of the Northern Tien-Shan's active faults were revealed. The strain sensitivity of rock massifs is estimated by the level of correlation between gravitational tidal effects and variations of electromagnetic parameters. The orientation of clusters of stable correlation corresponds to the strike of fault fractures on correlational polar diagrams (Fig. 2), what indicates the strain-sensitive nature of zones of dynamic influence of the Northern Tien Shan active faults.

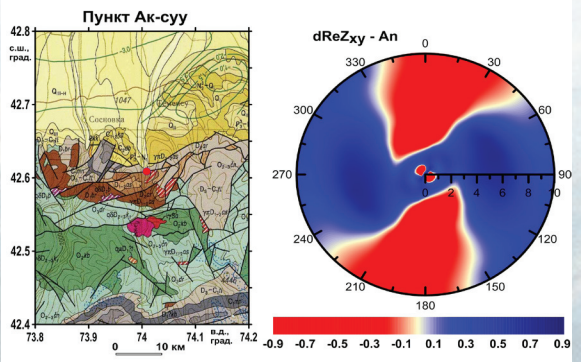


Figure 2.
Panel on the left is a fragment of geological map near the location of stationary point of MT-monitoring "Ak-Suu".
Panel on the right is a diagram of distribution of correlation coefficient (additional impedance Zxx and vertical component of tidal influence An) in polar coordinates, where T-period is shown on radius axis.

3. With a general consistency in the distribution of velocity of the total horizontal deformation along GPS and seismological data of the KNET network, a block of the Earth's crust with increased and potentially dangerous gradients of strain rate is identified on the territory of Central Tien Shan. During the observation period of 1998 - 2014 the high degree of positive correlation in the distribution of velocity of horizontal deformation for the near-surface part of the Earth's crust (depths up to 5 km, GPS data) and the Earth's crust seismically active layer (depths of 5-20 km, seismological data) is noted for a large part of investigated territory. The exception is the central zone of study area (Djumgal-Too Mountains), where lower velocities of near-surface dilatancy and higher rates of deformation in the seismically active layer of the Earth's crust are recorded. The revealed disharmony in distribution of near-surface and deep deformation indicates an energy-saturated and potentially dangerous volume of the Earth's crust from the point of view of manifestation of seismic events and faults activity.

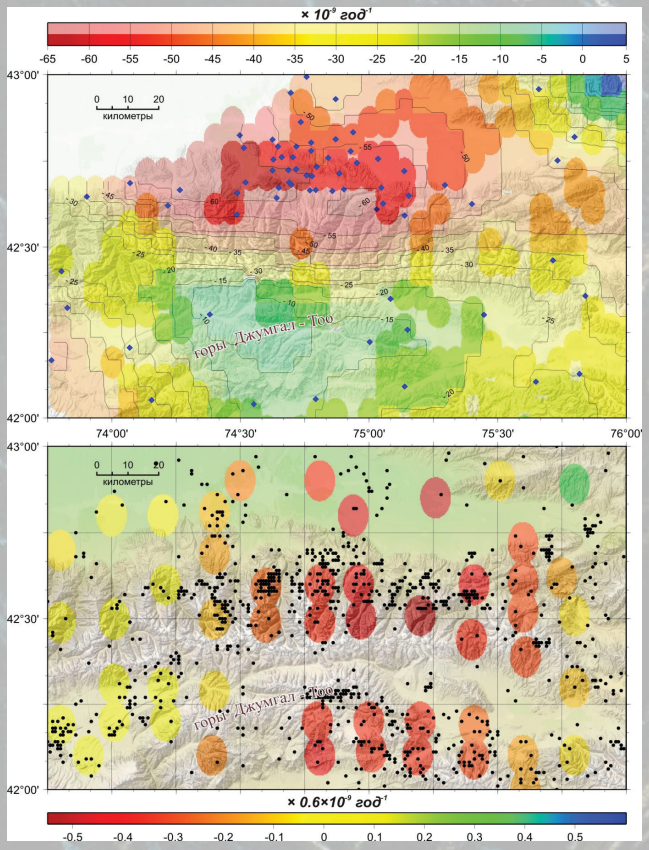
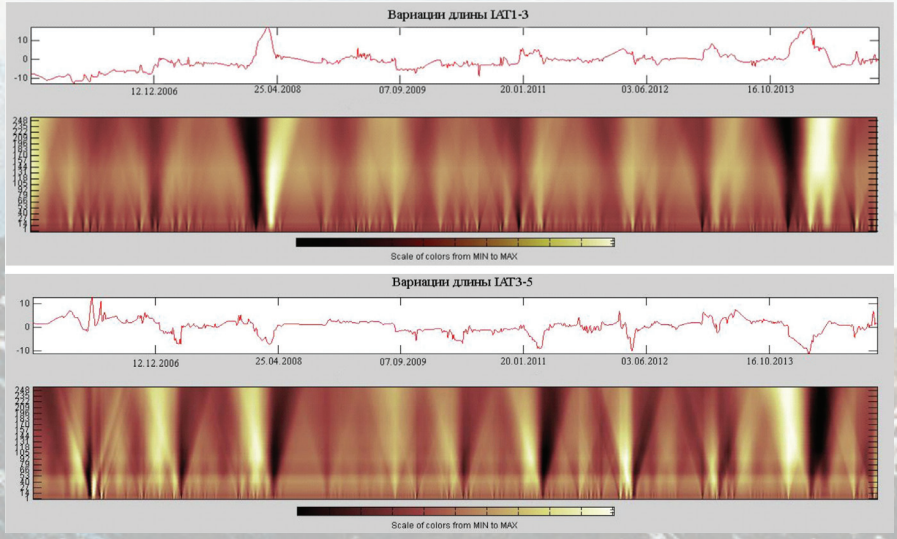


Figure 3 - Distribution of rate of total horizontal deformation (color ovals) for 1998-2014 observations on the territory of the Central Tien Shan:
Upper fig. – according to near-surface GPS observations, blue diamonds – GPS sites;
Lower fig.- according to seismological data, black points - earthquakes with solutions of focal mechanisms (5-20 km depth).

According to GPS observations data, the anisotropic (relative to cardinal directions) elastic deformations of the Earth's crust with regular intervals were revealed on the territory of Bishkek Geodynamic Polygon.

According toS GPS observations, for the baselines IAT1-3 (North-South) and IAT3-5 (East-West), the repeated elastic deformations with a periodicity of 1 year was revealed on the geodetic site. On the average, the deformation events start in December, and come to an end in May, with a cycle duration of 4-5 months. In the northern direction, at ~300 m, elongation cycles are regular (up to 22 mm or 7.3 × 10 5). In the east, at ~ 360 m, as a rule, with a delay of events for 20-30 days, shortening is observed (up to 16 mm or 4.3 × 10 5).



On the territory of Bishkek Geodynamic Polygon (Northern Tien Shan), a spatial and temporal relationship between the manifestation of local seismicity and variations in the deformation environment of the Earth's crust was recorded. The results of linear-angular and GPS observations in comparison with seismicity and focal mechanisms have made it possible to estimate the geodynamic situation during the local earthquake 10 of the energy class. A few days before the earthquake, according to GPS data, subsidence in this region of the Earth's surface with amplitude up to 20 mm was noted. In the period 5 days before and 2 days after the event, an average increase of 8 mm in length of the lines crossing the Shamsi fault was noted at 2 km from the source of earthquake. Such an increase in the fault width corresponds to the tectonic stresses variation in the fault region ~ 7 MPa.

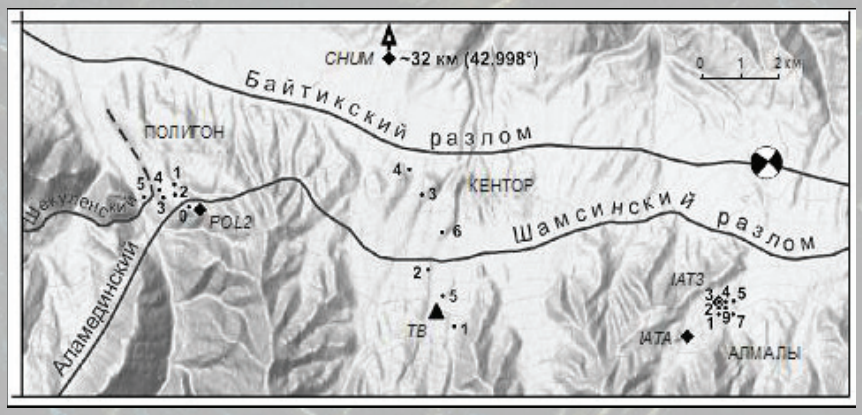


Figure. Scheme of the area under study with indication of sites location (sites and their numbers) of linear-angular observations POLYGON, KENTOR AND ALMALY (1), GPS measurement points IATA, IAT3, POL2, CHUM (2), remote sensing station (3) and the epicenter of earthquake, (4) - the focal mechanism of the source. Lines are active faults.

RS RAS INTERNATIONAL ACTIVITY

Every year, starting from 2009, the International Conference for young scientists and students "Modern Techniques and Technology in Scientific Research" takes place on the basis of RS RAS. Following the results of the conference the Book of Reports is published.

The work of the Conference fell into three main directions:

- Section 1. «Geophysical monitoring and geo-information systems» includes reports on methods and new software systems used for geoenvironment and ionosphere monitoring, and the results of their application.
- Section 2. «Natural and man-made hazards» includes reports on the prevalence and features of seismotectonic processes manifestations, landslides and mud flow and flood phenomena in Central Asia. This section also includes reports on man-made hazards associated with the operation of water-storage basins and mining in earthquake-prone areas.
- Section 3. «Interdisciplinary reports» includes reports on mechanics and dynamics of various phenomena and processes, as well as reports on modern mathematical and technological methods used in various scientific fields.

From 18 to 20 April 2018 the **X International Conference for young scientists and students "Modern Techniques and Technology in Scientific Research"** took place on the basis of Research Station RAS in Bishkek city.

The participants of X International Conference for young scientists and students "Modern Techniques and Technology in Scientific Research".
Field excursion.
Research Station RAS, 2018.

The participants of X International Conference for young scientists and students "Modern Techniques and Technology in Scientific Research".
Geodetic excursion.
Research Station RAS, 2018.

From 2000 to 2018 the RS RAS successfully held seven International Symposiums "Modern problems of Geodynamics and Geoecology of Intracontinental Orogens".

Within the frameworks of Symposiums the wide range of problems of following directions were discussed;

- Deep structure and evolution of the Earth's crust and upper mantle in the light of modern concepts of geodynamics. Instrumental method of study of the of intracontinental orogens lithosphere: heterogeneities, physical nature of boundaries;
- The stress-strain state of the Earth's crust, the problem of its block structure and self-similarity of geodeformation processes. Seismotectonics of intracontinental orogens areas;
- Comprehensive monitoring of seismic areas. Issues of Geosphere interaction, including the influence of physical fields on endogenous processes;
- Electromagnetic methods in the study of seismic regions and in monitoring of geodynamic processes. Development of methods for electromagnetic data inversion;
- Seismic hazard assessment, regional studies of seismic regime;
- Environmental and social consequences of endogenous and exogenous geological processes, catastrophic events prediction (earthquakes, landslides, landslides, etc.).

From 19 to 24 of June, 2017, on the basis of RS RAS t**he International Symposiums "Modern problems of Geodynamics and Geoecology of Intracontinental Orogens**" took place.

More information on Symposium could be found on the web-site of RS RAS **www.gdirc.ru; www.gdirc.kg.**

On 3 – 7 of July, 2018, the INTERNATIONAL JUBILEE SCIENTIFIC CONFERENCE "INFLUENCE OF EXTERNAL FIELDS ON SEISMIC REGIME AND MONITORING OF THEIR MANIFESTATIONS", devoted to 40th anniversary of Research Station of the Russian Academy of Sciences in Bishkek city, took place on the basis of RS RAS.

The conference was attended by 119 scientists and specialists from 7 countries (Russia, Kyrgyzstan, Kazakhstan, Uzbekistan, Tajikistan, Iran and Greece). 51 oral and 48 poster presentations were presented at the plenary and section sessions. In course of the Conference the exhibition-stand «Modern developments of software and hardware for geodynamic studies» was functioning.

Young researchers participation (more than 30 people) allowed them to learn more about modern scientific achievements in the field of Earth sciences, to present and discuss the results of their research with leading specialists.

On July 5, discussion club meeting took place, where the leading scientists in the field of Earth sciences discussed a wide range of issues addressing the impact of external fields on seismic regime, determined their attitude to the results achieved in this field and possible prospects for this direction development. The results presented by the Conference participants on other areas of complex geodynamic studies of seismically active regions were discussed as well. Within the Conference leading specialists - geologists and geophysicists - participated in the field geological excursion to RS RAS regime electromagnetic station «Shavai».

The Book of Abstracts of the Conference was published to the date of Conference opening.

More information on International Jubilee Conference could be found on the web-site of RS RAS **www.gdirc.ru; www.gdirc.kg.**

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