ISSN 0016-7029, Geochemistry International, 2016, Vol. 54, No. 5, pp. 475–483. © Pleiades Publishing, Ltd., 2016.
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CHRONICLE

9th International Biogeochemical School

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Received November 15, 2015; accepted November 18, 2015

DOI: 10.1134/S0016702916050025

INTRODUCTION

The 9th International Biogeochemical School "Biogeochemistry of Technogenesis and Modern Problems of Geochemical Ecology" was held on August 24–28, 2015 at the Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences (IVEP) in Barnaul. The school was organized by IVEP in cooperation with the Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences (GEOKhI); Institute of Soil Science and Agricultural Chemistry, Siberian Branch, Russian Academy of Sciences (Novosibirsk); Tomsk National Research Polytechnic University (NITPTU); Gornyi Altai State University (GAGU, Gorno-Altaisk); and Altai Agrarian State University (AGU, Barnaul) and was sponsored by the Russian Foundation for Basic Research and Department of Earth Sciences of the Russian Academy of Sciences. The school was attended by researchers from 82 scientific and educational institutions, as well as museums and applied scientific organizations of the Russian Federation, Belarus, Lithuania, Bulgaria, France, Sweden, Israel, Germany, Moldova, Mongolia, Kazakhstan, and Kyrgyzstan. The program included 165 presentations. The school was opened by the Director of IVEP Prof. **Yu.I. Vinokurov**, who pointed out the urgency of the 9th International Biogeochemical School and considerable contribution of scientists to the progress of biogeochemistry and geochemical ecology.

The 9th Biogeochemical School focused on the problems of anthropogenic alteration of biospheric taxons, evaluation of the role of biogeochemistry in economy, and development of modern biogeochemical techniques. These topics were discussed in plenary lectures and the following sessions of the school:

—biogeochemistry of major and trace elements and radionuclides; their global and local cycles;

—regional and global problems of the technogenesis of the biosphere and its taxons;

—biogeochemistry of aquatic ecosystems and influence of biogeochemical processes on catchments on the formation of hydrochemical runoff;

—problems of ecological monitoring of toxicant loading on the environment and new approaches to the organization of biogeochemical monitoring;

—biogeochemical problems in medicine and agriculture;

—methods of the analysis of chemical elements and compounds in natural and anthropogenic objects;

—biogeochemistry of soils and problems and prospects of the restoration and phytoremediation of contaminated soils of anthropogenic landscapes; and

—biogeochemical problems of the Arctic.

PLENARY SESSION

Twenty plenary lectures were presented. In the report "Technogenesis and Biogeochemical Evolution of Biospheric Taxons", **V.V. Ermakov and Yu.V. Kovalsky** (Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Moscow) noted that biogeochemistry is one of the most important systems sciences dealing with the elemental composition of living matter and biogenic migration of chemical elements and their compounds in the biosphere. Their lecture focused on the anthropogenic transformation of the biosphere, its consequences, need for the adaptation of economy, and development of geochemical ecology, a modern scientific field providing a basis for the biogeochemical investigation of biospheric taxons, their zoning, and regulation. In addition, Ermakov highlighted the concept of the balance of biogeochemical cycles, the energy state of the biosphere and its adaptation to anthropogenic factors, and the importance of investigations on the identification and correction of biogeochemical endemic diseases. He pointed out the most acute problems in the development of the science.

The monitoring of food safety in the food industry of Serbia was discussed by Prof. **L.N. Jovanović** (ALFA University, Beograd). She noted that the introduction of the HACCP system in the Republic of Serbia became obligatory in 2011 in accordance with the Law on Veterinary and the Food Safety Law. The main purpose of the study was the analysis of the main aspects of the HACCP methodology for its application in Serbian companies. Each producer is obliged to provide a certificate for food quality and safety.

The lecture of Prof. **A.V. Puzanov** "Biogeochemistry of the Altai–Sayan Mountain Land" illustrated the diversity and complexity of geomorphologic, geologic, hydrographic, and climate conditions; the contrasting lithochemical background; and the ecology of mountain soil formation and related diverse soil-forming processes in the system of vertical zoning of the Altai–Sayan mountain land. These factors resulted in a pronounced heterogeneity of the trace element composition of its soil and biogeochemical characteristics of Mn, Zn, Cu, Co, and Hg migration in regional soils, plants, and food products.

The presentation of Doctor in Agriculture **O.A. Elchininova** (Gorno-Altaisk) "To the 85th Anniversary of the Birth of M.A. Malgin, a Prominent Scientist in the Field of Biogeochemistry" was concerned with the biography and scientific achievements of the renowned scientist not only in biogeochemistry, but also in agricultural chemistry, soil science, and ecology. He had studied the biogeochemical situation in southern Western Siberia for almost 50 years and authored or coauthored more than 160 scientific publications. Malgin was the first to address the problem of iodine deficit in environmental zones of the Altai–Sayan mountain land and the potential danger of endemic goiter.

The history of radionuclide biogeochemistry was discussed by Prof. **L.P. Rikhvanov** in the lecture "Geochemistry of Nuclear Technogenesis". He pointed out that the second half of the 20th century was marked by the beginning of a new stage in the evolution of the biosphere related to the utilization of nuclear energy. Since the onset of the epoch of nuclear technogenesis, artificial radioactive isotopes and elements (transuranium elements) have appeared in the biosphere. The local concentrations of alpha-emitting elements in the biosphere have changed by factors of 2.5–3.0. Anthropogenic nuclides were involved into biological cycles, which gave rise to a number of global and local environmental problems. Rikhvanov also pointed out the development of a new scientific discipline, geomedicine, which has some common features with biogeochemistry and the geochemical ecology of humans.

Several authors addressed V.I. Vernadsky's concept on the geochemical role of living matter. Professor **S.A. Ostroumov** (Moscow State University) presented the lecture "Development of V.I. Vernadsky's Concepts on the Role of Living Matter in the Biogeochemistry of the Biosphere" and proposed a new interpretation of experiments on the interaction of chemical elements with living matter. These experiments focused on the sorption of chemical elements on biomass and mortmass of aquatic plants and biological detritus. It was concluded that the concept of the biogenic migration of chemical elements should be revised with emphasis on their immobilization. Professor **N.V. Baranovskaya** (Tomsk Polytechnic University) discussed modern biogeochemical ideas in her lecture "Geochemistry of Living Matter" by the example of the elemental composition of humans and demonstrated its dependence on the particular habitat. The lecture of Prof. **V.S. Besel** (Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences, Yekaterinburg) "Once More about Living Matter" concerned the existence of a system of histohematic barriers in animal organisms. This results in significant differences between the concentrations of a number of elements (Ca, Cr, Fe, Co, Br, Sb, La, Ce, and Sm) in organs (liver), placenta, and fetus in background and chemically polluted environments. This enables normal functioning of the reproductive system of mammals and population sustainability under extreme conditions.

The character of anthropogenic metallization of soils starting from mining activity was considered in the lecture of Prof. **V.A. Alekseenko** "Problem of the Technogenic Metallization of Soils". Areas of different size with specific contents of metals in soils were distinguished within biospheric taxons. The formation of such areas begins from the mining of mineral deposits and continues up to the disposal of devices and materials, which is accompanied by increasing soil metallization in agricultural landscapes. Professor **G.G. Morkovkin** (Altai Agrarian State University, Barnaul) reported the results of a study on the estimation of heavy metal contents in the soils of the steppe zone of Altai krai.

Professor **E.V. Evstaf'eva** (Georgievskii Crimean State Medical University, Simferopol) noted that, in line with the methodical recommendations of the Long-Range Transboundary Air Pollution (LRTAP) Convention, critical loads are used as an ecological parameter of the permissible level of pollutant impact on different types of ecosystems; the critical loads allow accounting for the natural diversity of ecosystems and their resistance to anthropogenic impacts. Systematic medical–physiological and biogeochemical investigations of the population of the Crimean Peninsula revealed certain relations between biological and geochemical factors. The obtained integrated quantitative estimates can be used for ecological assessment on a regional scale.

The presentation of Prof. **A.I. Syso** (Institute of Soil Science and Agricultural Chemistry, Siberian Branch, Russian Academy of Sciences, Novosibirsk) "Russian Hygienic Allowances of Ecological Estima-

tion of Soils, Their Scientific Justification, and Problems of Use" contained an in-depth analysis of hygienic standards existing in the Russian Federation and demonstrated their weak scientific justification because of poorly developed methodic approaches. With respect to major and trace elements, the standards contradict the knowledge of agricultural chemistry, biogeochemistry, and geochemistry on the natural level of their contents in the soils of different regions, necessity for plants, and danger for the environment. The use of such parameters for the assessment of soil pollution may be misleading.

BIOGEOCHEMISTRY OF MAJOR AND TRACE ELEMENTS AND RADIONUCLIDES; THEIR GLOBAL AND LOCAL CYCLES

The session comprised nine presentations. **G.A. Leonova** (Sobolev Institute of Geology and Mineralogy, Siberian Branch, Russian Academy of Sciences, Novosibirsk) considered the chemical and microbiological composition of a 4-m core of Holocene sapropel from Lake Kotokel (Baikal region). It was shown that the sapropel was formed mostly from phytoplankton, and bacteria played the major role in the decomposition of organic matter and formation of organomineral complexes and pyrite.

Professor **Yu.L. Mel'chakov** (Ural State Pedagogical University, Yekaterinburg) pointed out incorrect interpretation of migration processes in landscapes related to the inadequate estimation of the atmospheric cycle. He demonstrated an important role of evapotranspiration in the background taiga landscapes of the Urals and attempted to estimate the poorly known flux of endogenous gas emission.

The reports of researchers from the Kazakh Republic on the biogeochemistry of radionuclides attracted much attention. **Yu.G. Stril'chuk** (Filial of the Institute of Radiation Safety and Ecology, National Nuclear Center, Kurchatov, Kazakh Republic) determined radionuclide contents in environmental objects and concluded that they are not hazardous over most of the area studied; hence, the territory can be used for economic activity. **M.T. Aktaev** and colleagues analyzed radionuclides in the water of Lake Atomnoe in the area of the former Semipalatinsk test site. It was shown that the distribution of anthropogenic radionuclides in the lake is related to the stratification of the water column.

A.I. Mal'tseva (Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino) discussed the character of biogeochemical transformation of organic matter in a model experiment. She explored the influence of a mineral matrix on this process and concluded that bentonite has a higher stabilizing ability compared with kaolinite.

I.G. Boyarskikh (Central Siberian Botanical Garden, Novosibirsk) presented results obtained by a research team (Central Siberian Botanical Garden, Siberian Branch, Russian Academy of Sciences; Institute of Soil Science and Agricultural Chemistry, Siberian Branch, Russian Academy of Sciences, Novosibirsk; and Center of Natural Sciences, Vilnus, Lithuania) on the activity of natural and anthropogenic radionuclides at the fault zones of the Ust'-Koksinskii district of Gornyi Altai. They established the effect of geophysical and geochemical anomalies on the intensity of mutation of the species *Lonicera caerulea* and accumulation of biologically active phenol compounds in fruits of plants growing under stress conditions.

The geochemistry of precipitation in the taiga zone of the Komi Republic was addressed by **M.I. Vasilevich** (Institute of Biology, Komi Scientific Center, Ural Branch, Russian Academy of Sciences, Syktyvkar). It was concluded that the chemical composition of the snow cover of uncontaminated areas of the taiga zone is formed mainly owing to distant transport, whereas the contribution of local sources is insignificant.

I.N. Drozdova (Komarov Botanical Institute, Russian Academy of Sciences, St. Petersburg) considered the accumulation of heavy metals in soils and plants of the North Caucasus. She detected regional features of heavy metal migration in the soil–plant system and identified species promising for the monitoring of heavy metal contamination in arid environments.

Several presentations of researchers from the Institute of Water and Environmental Problems of the Siberian Branch of the Russian Academy of Sciences (Barnaul) addressed the biogeochemical estimation of the landscapes of Altai krai. **O.A. Elchininova** showed that copper contents are close to the average crustal value in the soil-forming rocks of the Altai mountain region, higher than this level in the soils, and comparable with the background contents in various regions of Russia in the plants. **S.V. Baboshkina** described the results of an investigation of the chemical composition of various soil types of the high-mountain Ukok Plateau. It was found that the concentrations of most elements are no higher that the mean values in the uncontaminated soils of Altai and global mean values; significantly higher contents of P, as well as Zn, Cu, V, and Cr were observed in the northeastern part of the plateau. It was noted that the distribution of metals in the soil profile of the Ukok Plateau is rarely accumulative, which indicates the absence of current anthropogenic pollution. **Yu.V. Robertus** discussed the problem of the formation of anthropogenic negative geochemical anomalies in Gornyi Altai. He highlighted the role of the input of particles with low contents of chemical elements in this process. **S.N. Balykin** reported the results of landscape geochemical investigations of the terrestrial and aquatic ecosystems of the position area and adjacent territories of the Vostochnyi

spaceport before the beginning and during various stages of its construction.

I.V. Alekseenko (Moscow State University) considered local and global problems of the technogenesis of the biosphere and its taxons and emphasized the consequences of forest fires under various landscape conditions of the Baikal Biosphere Reserve and changes in the properties of taiga soils. It was shown that the main landscape factors controlling the degree of soil transformation are the slope exposure and the type of vegetation.

Very interesting results were reported by **S.V. Mukhacheva** (Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences, Yekaterinburg). She showed that, despite the significant decrease in the intensity of industrial emissions, the content of major pollutants in the diet and organism of forest voles did not change significantly. In her opinion, these results support the inertia hypothesis on the long-term restoration of terrestrial ecosystems after reduction or cessation of emission.

S.A. Ostroumov (Biological Faculty of Moscow State University) presented new experimental data on interaction between chemical elements and biogenic materials. The results on the sorption and immobilization of chemical elements are of theoretical significance and may have applications to the development of environmental biotechnologies.

BIOGEOCHEMISTRY OF AQUATIC ECOSYSTEMS. INFLUENCE OF BIOGEOCHEMICAL PROCESSES IN CATCHMENTS ON THE FORMATION OF HYDROCHEMICAL RUNOFF

Eleven reports were presented during this session. Professor **V.F. Zaitsev** (Astrakhan State Technical University) discussed some features of selenium accumulation by the organs and tissues of sturgeon. He supposed that the presence of selenium compounds plays an important role in the low-temperature tolerance of Russian sturgeon. Some problems of the ecological and biogeochemical state of the Kuril–Kamchatka region, as a biogeochemical province, were considered by Prof. **N.K. Khristoforova** (Far East Federal University, Vladivostok). She showed that the concentrations of toxic microelements (Hg, As, Pb, and Cd) in pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*Oncorhynchus keta*) were lower than the maximum admissible concentrations for seafood, and the contents of Zn, Cu, and Pb reflected the elemental composition of the salmon habitat.

Several reports on the lacustrine sapropel beds of Western Siberia were presented. In particular, **V.D. Strakhovenko** (Sobolev Institute of Geology and Mineralogy, Siberian Branch, Russian Academy of Sciences, Novosibirsk) established that the lacustrine sapropels of the Baraba plain are dominated by organic–siliceous sapropel, which is due to the prevalence of diatoms among the phytoplankton of these lakes and silicon-accumulating reed among the aerial–aquatic vegetation. **N.I. Ermolaeva** (Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Novosibirsk) considered the dependence of the composition of sapropel from the lakes of southern Ob–Irtysh interfluve on hydrochemical conditions and the level of bioproductivity in the lake. Aquatic organisms play a significant role in the migration of N, P, and C_{org} during sapropel formation. **D.A. Allayarov** (Tyumen State University) quantified copper sorption by bottom sediments. It was found that the limiting sorption is correlated with the surface area of the bottom sediments. **A.V. Alekseenko** (Gornyi National Mining University, St. Petersburg) reported the results of the biogeochemical monitoring of aquatic landscapes of the Tsemes Bay on the basis of the evaluation of chemical element accumulation in macrophytes and geobotanical data. **A.A. Khvashchevskaya** (Tomsk National Research Polytechnic University) showed that the appearance of periphyton owing to the activity of iron bacteria in water supply systems is related to their poor state rather than the quality of drinking water in them. **D.M. Bezmaternykh** (Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Barnaul) reported new data on the environmental state of streams in the area of the position site of the Vostochnyi spaceport. He argued that the monitoring system of the spaceport should become part of the ecological monitoring of Roskosmos. Optimal sites for regular sampling and methods of biological analysis were proposed. **T.A. Rozhdestvenskaya** (Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Barnaul) described the dependence of the hydrochemical runoff of the rivers of Gornyi Altai during extreme rainfall floods on the soil-geochemical conditions of catchments. She expressed concern about the increasing contents of nitrogen mineral compounds in the surface waters and pointed out the preferential occurrence of heavy metals in a suspended form in the river waters of anthropogenically transformed landscapes during rain floods.

Professor **V.D. Korzh** (Shirshov Institute of Oceanology, Russian Academy of Sciences) used the methodology of empirical generalization to construct the System of the distribution of chemical elements in the hydrosphere; in his opinion, it has a strong predictive potential and may serve as an ecological standard.

PROBLEMS OF ENVIRONMENTAL STANDARDS

A special session considered the problems of ecological standards for toxicant impacts on the environment and new approaches to the organization of biogeochemical monitoring. This session comprised several reports of researchers from the Tomsk National

Distribution of the presentations with respect to countries and the number of young participants

School number	Number of presentations					
	total	Russian	non-Russian	CIS countries	other contries	young scientists
1	38	32	6	5	1	5
2	182	162	20	12	8	15
3	205	184	21	14	7	25
4	171	151	20	14	6	26
5	157	110	47	43	4	23
6	154	142	12	4	8	25
7	88	76	12	5	7	26
8	142	92	50	43	7	29
9	167	141	26	19	7	30

Research Polytechnic University. They emphasized the use of the elemental composition of living matter as an ecological and biogeochemical marker, which allows defining the geochemical signature of the region (**B.R. Soktoev, Sh.Zh. Arynova**, etc.). **E.N. Chernova** (Pacific Institute of Geography, Far East Branch, Russian Academy of Sciences, Vladivostok) considered indicator organisms from the western part of the Sea of Japan and methods for the calculation of the upper and lower threshold concentrations of heavy metals. Professor **S.A. Ostroumov** (Faculty of Biology, Moscow State University) also discussed the acceptable level of toxicant loads on water systems and reported new observations on the biotic self-purification of water.

BIOGEOCHEMICAL PROBLEMS IN MEDICINE AND AGRICULTURE

T.K. Krupskaya and colleagues (Grodno University, Republic of Belarus) presented the report "New Opportunities for Monitoring of Endoecological Status of Handicapped Children: Feasibility of Dietary-Based Correction". **N.K. Dzhabarova** reviewed the studies of the Filial of the Tomsk Research Institute of Health Resort Treatment and Physiotherapy on the use of natural mineral table waters of Siberia for health improvement. **M.A. Solodukhina** (Institute of Natural Resources, Ecology, and Glaciology, Siberian Branch, Russian Academy of Sciences, Chita) and **L.A. Mikhailova** (Chita State Medical Academy) emphasized the importance of the investigation of endemic diseases in Transbaikalia.

Three reports of researchers from the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences were presented during this section. **V.A. Safonov** described relations between the antioxidant and trace element status of cattle. **S.F. Tyutikov** reported the use of the chemical elemental composition of animal hair for the diagnosis of chronic microelementoses. **V.Yu. Berezkin** and colleagues estimated iodine supply in the agricultural landscapes of Bryansk oblast. A number of authors discussed the trace element composition of plants and food with application to the correction of microelementoses of humans and animals (**T.M. Maimanova** et al., Gorno-Altaisk State University and Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Barnaul; **E.A. Kolesnikova** et al., Tomsk National Research Polytechnic University; **S.V. Baboshkina** et al., Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Barnaul, and Blagoveshchensk State Pedagogical University).

ANALYTICAL METHODS FOR CHEMICAL ELEMENTS AND COMPOUNDS IN NATURAL AND ANTHROPOGENIC OBJECTS

The session was opened by **V.N. Danilova** (Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences), who described new opportunities of the use of HPLC-NAM spectrofluorimetry for determining biologically active sulfur-bearing compounds. **L.I. Kalmykova** et al. (Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences) reported the results of thermodynamic modeling of iodine and selenium speciation in the water–rock system and proposed their landscape geochemical interpretation. **Zh.K. Shomanova** presented the results obtained by researchers from Kazakhstan on the composition of ash–slime waste of the Aksu ferroalloy plant for utilization and catalyst production.

BIOGEOCHEMISTRY OF SOILS AND REMEDIATION OF ANTHROPOGENIC LANDSCAPES

V.S. Artamonova (Institute of Soil Science and Agricultural Chemistry, Siberian Branch, Russian Academy of Sciences, Novosibirsk) evaluated the

growth characteristics of soil bacteria *Azotobacter chroococcum* and freshwater plant of the genus *Lemna* in the presence of anthropogenically contaminated meltwater and soil. It was found that ecological tactics of growth advantageous for survival are activated by *Azotobacter* in chemically contaminated environments. **G.K. Vasil'eva** (Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino) described a new combined approach to the sorption bioremediation of soils, which can be used for the elimination of the consequences of accidental spills and persistent soil pollution. **L.N. Belan** (Life Safety Research Institute, Ufa) considered persistent organic pollutants in urban soils of Bashkiria. In his opinion, the highest levels of local soil contamination with persistent organic compounds in the region are observed in the towns of Ufa (in the area affected by industrial emissions) and Sterlitamak.

BIOGEOCHEMICAL PROBLEMS OF THE ARCTIC

This session comprised several reports on the accumulation of metals and ash elements in the organism of wild reindeer and willow ptarmigan (*Lagopus lagopus)* near Norilsk, polyarene accumulation by tundra plants, and the chemical composition of water from the small lakes of the Kola Peninsula. In particular, **P.V. Kochkarev** (Central Siberian State Biospheric Reserve, Krasnoyarsk krai) considered the dynamics of the trace element composition of the organs and tissues of wild reindeer during northward migration (away from the contamination source), and revealed a decrease in the heavy metal contents. **M.M. Bazova** (Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences) investigated variations in water chemistry in the small lakes of the Kola Peninsula and showed that an increase in dissolved organic matter content is caused by a decrease in the precipitation of sulfur and nitrogen oxides. **E.V. Yakovleva** (Institute of Biology, Komi Scientific Center, Ural Branch, Russian Academy of Sciences) established that the contents of polyaromatic hydrocarbons (PAH) on the surface of plants in the tundra zone was largely controlled by external factors, whereas the PAH content inside the plants depended on their physiological features and polyarene absorption capacity.

POSTER SESSION

The poster session included 12 presentations on new results of investigations of biogeochemical risk factors in the genesis of the Urov endemic disease, metal enzymes and biogeochemistry of rhenium (Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences), regional zoning (Tomsk National Research Polytechnic University), correlation of carcinogenic diseases with environmental factors (Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences and Altai Filial of the Blokhin Russian Cancer Research Center), and characteristics of the physiological growth of adolescents in areas exposed to anthropogenic loads (Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Barnaul; Altai State University).

A research team under the leadership of Prof. **A.V. Puzanov** (Institute of Water and Environmental Problems, Siberian Branch, Russian Academy of Sciences, Barnaul) prepared several presentations on the anthropogenic transformation of biospheric taxons and methods of their investigation, including "Environmental Aspects of the Influence of Anthropogenic–Mineral Objects on the State of Surface Waters by the Example of the Gold Beneficiation Plant of the Veselyi Mine" and "Features of Kerosene tc-1 Distribution at the Emergency Passage on the Soil". In addition, several posters described the results of biogeochemical investigations of steppe and forest landscapes. **M.M. Goryachaya, A.N. Bestuzheva, and V.V. Lobyntsev** (ZAO NPF ARGOS, St. Petersburg) presented innovative assessment of the extent of pollutant spread in an aquatic environment related to accidents of marine and space systems.

FINAL SESSION OF THE 9th BIOGEOCHEMICAL SCHOOL

The final discussion of the reports and problems considered during the meeting focused on the unsolved problems of ecological standards, methodical issues, and state of education in the biogeochemistry specialty. **E.V. Evstaf'eva** proposed to introduce biogeochemically justified standards. In her opinion, the further use of maximum admissible concentrations as reference values for the identification of pollution in various environmental objects has become inadequate. In the light of modern knowledge and international practice, it is necessary to employ modern ecological standards, which is declared in appropriate state documents; their methodic basis is described in the modern international guides (European Economic Commission, Long-Range Transboundary Air Pollution Convention, LRTAP). Evstaf'eva argued that the ministries of ecology and health care must estimate the state of habitats and its influence on the health using ecological parameters of critical loads and their excesses as a necessary analytical tool for administrative decisions, which is reflected in risk assessment guides. **A.I. Syso**, Managing Director of the Institute of Soil Science and Agricultural Chemistry of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk) criticized some Russian hygienic parameters used for the ecological assessment of soils. He emphasized their poor scientific justification and need for improvement. Professor **L.P. Rikhvanov** (Tomsk

National Research Polytechnic University) also discussed the problem of standards. He noted that the method of biomarkers, cytogenetic characteristics of various test objects, reference estimates, and estimation of the deviation from the reference values should be more actively used for the assessment of toxicity. He also recommended the participants to publish more actively the results of their scientific studies in the journal *Bulletin of the Tomsk Polytechnic University*.

Professor **S.A. Ostroumov** (Moscow State University) pointed out insufficient participation of Russian ecologists in international conferences. He recommended providing additional funding for the participation of Russian researchers in European and World conferences. Professor **N.I. Khristoforova** (Far East Federal University) suggested that the program of the future 10th Biogeochemical School should include several lectures on particular directions in biogeochemistry, which would be especially instructive for young scientists, in order to elucidate main problems and possible approaches to their solution.

In the final talk, Prof. **V.V. Ermakov** considered the organization of an interinstitutional scientific council on the problems of biogeochemistry and geochemical ecology. He pointed out that the goal of the organization and functioning of the council is the coordination of studies in biogeochemistry and cooperation of experts in different disciplines studying biogeochemical problems on a common methodical basis established by V.I. Vernadsky and his pupils and followers. He emphasized the special role of the council under the conditions of the market economy and, primarily, in regard to the development and production of numerous food additives containing major and trace elements. Their uncontrolled use ignoring specific biogeochemical conditions (contents of elements in the environment and food products) may be hazardous to the health of humans and animals.

Ermakov also informed the participants that a Dissertation Council was organized on the specialty biogeochemistry (no. 03.02.09). Currently the scientific specialty biogeochemistry is approved by the High Attestation Commission of the Russian Federation in the field of biological sciences, and candidate's and doctoral degrees in biology and chemistry can be granted based on dissertations in this discipline. However, the systems character of the specialty may be lost. It is more expedient to create a combined dissertation council for studies in geological, biological, and chemical sciences, for instance, at the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences and other large biogeochemical centers, including leading experts in biogeochemistry from different institutes and universities.

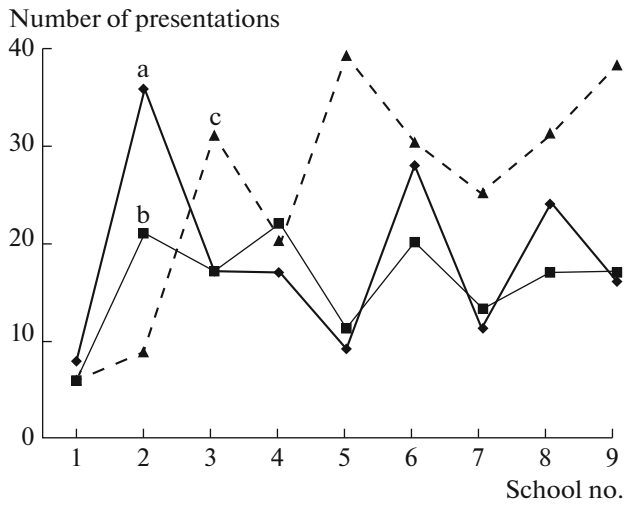
Finally, Certificates of Appreciation of the Organization Committee of the V.V. Koval'skii Biogeochemical Readings and Koval'skii Medals were awarded to Prof. A.V. Puzanov (Barnaul), Prof. A.I. Syso (Novosibirsk), Prof. L.P. Rikhvanov (Tomsk), Prof. Yu.I. Erokhin (Omsk), and Prof. V.A. Alekseenko (Novorossiisk); and Letters of Appreciation were presented to Prof. L.N. Jovanovic (Beograd), Prof. E.V. Evstaf'eva (Simferopol), Prof. N.V. Baranovskaya (Tomsk), Prof. Yu.L. Mel'chakov (Yekaterinburg), candidate in biology S.B. Baboshkina, candidate in biology T.A. Rozhdestvenskaya, candidate in physics and mathematics D.N. Troshkin, junior researcher I.A. Troshkova, and secretary Ya.E. Kuznyak (Institute of Water and Environmental problems, Siberian Branch, Russian Academy of Sciences, Barnaul) for their contribution to the development of biogeochemistry and geochemical ecology and organization of the school.

In general, the participants appreciated the high level of conference organization under the supervision of the head of the Organization Committee, Deputy Director of the Institute of Water and Environmental Problems of the Siberian Branch of the Russian Academy of Sciences Prof. A.V. Puzanov, members of the Organization Committee, and Director of the Institute Prof. Yu.I. Vinokurov. They emphasized the urgency of problems discussed in the presentations and a number of new methodical and practical solutions for various issues of biogeochemistry and ecology; efficient development of a biogeochemical scientific center at the Institute of Water and Environmental Problems aimed at multidisciplinary systems investigations; and the need to combine scientific efforts on the problems of trace elements in the framework of a scientific and industrial council.

COMPARATIVE CHARACTERISTICS OF THE 9th BIOGEOCHEMICAL SCHOOL

It should be noted that the number of report presented during different biogeochemical schools varied depending on the place, but remained relatively stable over the last three years. Since 2000, the number of young scientists has increased up to 20–25 and remained constant, and the number of foreign participants (except for the Commonwealth of Independent States, CIS) was no higher than eight (table). The high number of participants from the CIS in Semey (formerly Semipalatinsk, Kazakhstan) and Grodno (Belarus) was related to the activity of local researchers.

The analysis of the number of reports on different research directions indicates a decrease in the number of reports on the medicinal and veterinary aspects of biogeochemistry (figure). In contrast, the number of innovative reports, though significantly variable, has increased up to 2015. In addition, from school to school, there is an increase in the number of reports on the anthropogenic transformation of biospheric taxons and problems of biogeochemical indicators of their ecological state.



Distribution of the number of presentations on the biogeochemical schools: (a) medicine, (b) veterinary and livestock breeding, and (c) innovations.

RECOMMENDATIONS OF THE PARTICIPANTS OF THE 9th INTERNATIONAL BIOGEOCHEMICAL SCHOOL

(1) Available data on biogeochemical processes and phenomena should be systematized, and the theoretical basis of biogeochemistry and the scientific legacy of V.I. Vernadsky should be developed.

(2) Theoretical aspects on the transport and interaction of biogeochemical fluxes should be further developed on the basis of the concept of geochemical fields and modeling of biogeochemical processes.

(3) Comprehensive paleobiogeochemical investigations are necessary for the estimation of the tendencies of changes in the global and local cycles of chemical elements.

(4) The methods of accounting for (inventory) transformations of the chemical elemental and isotopic composition of living matter in the biosphere should be improved.

(5) Additional comprehensive investigations are needed on the interaction of major and trace elements in biogeochemical cycles.

(6) The speciation of chemical elements in the environmental objects and organisms should be more actively investigated. A methodology should be developed for combined biogeochemical investigations and methods of the analysis of the elemental and molecular composition of natural materials.

(7) The system of biogeochemical monitoring, regional zoning, and mapping should be modernized. It is necessary to launch a mega-project on updating, using modern GIS techniques, the map of biogeochemical zoning of the former USSR, which was created under the supervision of V.V. Koval'skii in the 1970s.

(8) New and existing biogeochemical innovations should be developed and improved for application in the economy, medicine, and veterinary.

(9) The standardization of ecological factors (trace elements, toxic metals and their compounds, and radionuclides) should be investigated more actively accounting for variations in the regional background. The list of biogeochemical and ecological criteria for the assessment of various landscapes, aquatic ecosystems, and soils has to be expanded, refined, and adapted to international standards.

(10) The methods and methodology of biogeochemical indicators for the ecological state of biospheric taxons should be improved. New biogeochemical techniques should be developed for exploration of mineral deposits and extraction of ore elements.

(11) The equipment of research and applied laboratories should be modernized by introducing modern scientific instruments, unified analytical methods, standards, and reactants.

(12) Operations on the rehabilitation of natural environmental systems contaminated with heavy metals and radionuclides should be conducted using modern efficient biogeochemical techniques of utilization and disposal of industrial waste and discharges.

(13) Large integration projects should be proposed on the diagnosis and correction of microelementoses in the framework of international scientific cooperation. Special emphasis should be placed on the prevention of endemic, cardiovascular, and carcinogenic diseases of humans and correction of the trace element status of the population of areas affected by the Chernobyl nuclear power plant accident.

(14) It is expedient to create new and activate existing scientific and applied centers on biogeochemistry, agricultural biogeochemistry, and aquatic biogeochemistry.

(15) More attention should be paid to education in the fields of biogeochemistry and geochemical ecology. Efforts of different schools in the biogeochemistry of heavy metals and radionuclides should be combined to publish textbooks and handbooks on ecological and biogeochemical problems accounting for specific regional features.

(16) It is recommend to the ministry of education of the Russian Federation to introduce in full extent the specialty Biogeochemistry (03.02.09) into the classification and organize appropriate dissertation councils for granting doctoral and candidate degrees in biology, geology and mineralogy, and chemistry.

(17) In order to coordinate biogeochemical investigations, development of technologies and their approbation, and creation of joint projects on the prevention of microelementoses, it is advised to organize a multidisciplinary scientific and industrial

council on the problems of biogeochemistry under the Russian Academy of Sciences with the participation of other countries.

(18) The publishing of the Proceedings of the Biogeochemical Laboratory should be continued and recommended for the inclusion into the list journals on chemical, biological, and geological–mineralogical sciences of the High Attestation Commission of the Russian Federation. A new international journal on problems in biogeochemistry and geochemical ecology should be organized in Russia, and its electronic version should be registered.

(19) It is necessary to recommend the Federal Agency of Scientific Organization to support the organization of the international symposium "Biogeochemical Ideas of V.I. Vernadsky and Their Development" in 2016 at the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences. This symposium will be dedicated to the 90th anniversary of the biogeochemical laboratory (BIOGEL) grounded by Vernadsky.

(20) The 10th International Biogeochemical School "Modern Problems of the State and Evolution of Biospheric Taxons" is planned to be held in 2017 at the Institute of Agricultural Chemistry and Soil Science of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk) and the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences.

The cultural and educational program of the school included excursions in Barnaul, a trip to Gornyi Altai, excursions to the museum and tourist complexes of Gornyi Altai, and a short course on biogeochemical field investigations in mountainous regions.

The participants of the 9th International Biogeochemical School strongly believe that this international scientific forum will push the development of fundamental and applied investigations in biogeochemistry and geochemical ecology and will promote further cooperation of scientific teams from universities and academic institutions of various countries.

The materials of the school were published in *Biogeochemistry of...* (2015).

This chronicle is based on the lectures, presentations, and materials of the 9th Biogeochemical School.

REFERENCES

1. *Biogeochemistry of Technogenesis and Modern Problems of Geochemical Evolution* (in 2 Volumes) (Barnaul, 2015) [in Russian].

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