

TTP TITLE: Contaminant Transport Modeling Studies of Russian Sites

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Summary

Lawrence Berkeley Laboratory (LBL) established mechanisms that promoted cooperation between U.S. and Russian scientists in scientific research as well as environmental technology transfer. Using Russian experience and U.S. technology, LBL developed approaches for field investigations, site evaluation, waste disposal, and remediation at Russian contaminated sites. LBL assessed a comprehensive database as well as an actual, large-scale contaminated site to evaluate existing knowledge of and test mathematical models used for the assessment of U.S. contaminated sites.

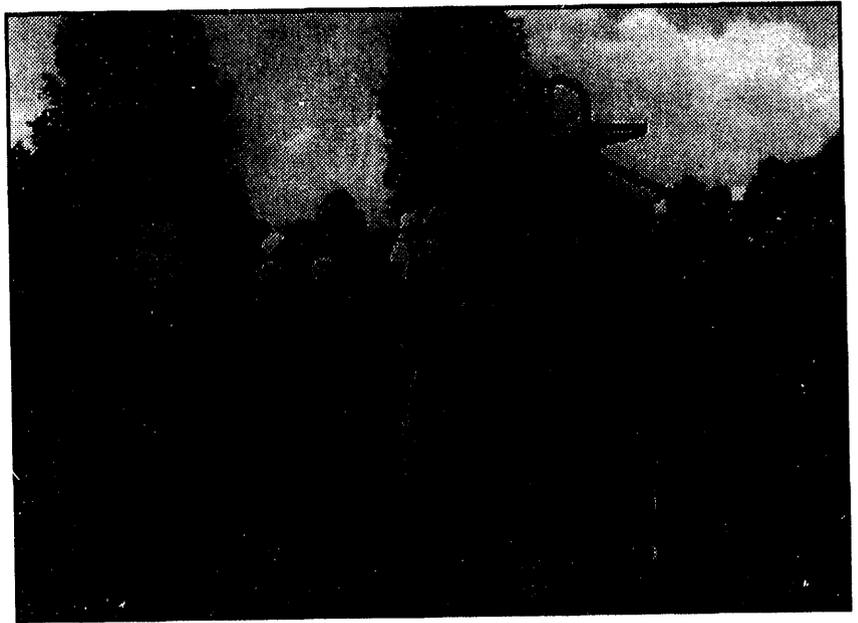
Background

Nuclear waste management and environmental remediation at Chelyabinsk is administered by the Mayak Production Association and the Ministry of Atomic Energy of the Russian Federation (MINATOM). Cooperative efforts with Russian scientists affiliated with MINATOM are conducted under the auspices of the Department of Energy (DOE)/MINATOM Joint Coordinating Committee on Environmental Restoration and Waste Management (JCCEM).

Initial discussions concerning cooperation between U.S. and Russian scientists took place during a U.S. delegation visit to Chelyabinsk in October 1991. They prepared a preliminary joint proposal for cooperative study on data transfer, data evaluation, and modeling. The level of commitment was reconfirmed during a visit by a DOE/Office of Environmental Management (EM) delegation to Russia in November 1992. The focus in FY93 was on the hydrogeology and geochemistry around the highly contaminated Lake Karachai and along the Techa River.

The 1957 high-level liquid waste tank explosion at Chelyabinsk released 2 million curies that spread along a track of more than 200 km. Medium-level wastes were directly discharged into the Techa River from 1949-1957, contributing to the contamination of the Arctic Sea. After 1951, medium-level wastes were continuously sent to Lake Karachai, which currently contains 120 million curies of radioactive wastes. The 1967 Lake Karachai lakeshore dust-spread accident released 600 curies; while in comparison, the Three Mile Island accident in

the U.S. released between 5 and 50 curies. Since the early 1960's, data were collected from over 160 wells in the Lake Karachai region and about 200 wells in the vicinity of the cascade of reservoirs along the Techa River. Though the quality of the data needs to be evaluated, it forms a data base that can be used to study various physical and chemical processes present during radioactive contaminant transport and to test advanced mathematical modeling techniques and codes.



Shown is the "plow" used to "bury" radioactive contamination from the 1957 HLW tank explosion at Mayak.

Activities

Invitation of Russian Scientists to U.S.

Each year LBL invites several Russian scientists to work at LBL for a period of 1 - 3 months. The 1993 visitors had extensive experience in field testing, data analysis, and modeling/laboratory studies. They were also active in the study of contaminant transport and nuclear waste disposal in the Chelyabinsk region. U.S. and Russian scientists at LBL collaborated to study the characterization of contaminated sites and alternative remediation strategies.

Scientists invited to work at LBL in FY93 included:

- Professor Valery Mironenko, St. Petersburg Mining Institute, April to July 1993;
- Dr. Mikhail Mironenko, Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, May to August 1993;
- Professor Alex Pek and Dr. Victor Malkovski, the Institute of Geology of Ore Deposits, Russian Academy of Sciences, May to July 1993;

- Dr. Seregey Podzniakov, Moscow State University, July 1993 to June 1994 (Post Doctorate); and
- Dr. Igor Khodakovsky, Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, visited LBL in June and in September.

Coordination with U.S. Institutions and Private Industries

LBL has coordinated with interested U.S. national laboratories, research institutes, universities, and private industry including Pacific Northwest Laboratory (PNL); Sandia National Laboratory (SNL); Argonne National Laboratory (ANL); Lawrence Livermore National Laboratory (LLNL); Los Alamos National Laboratory (LANL); Oak Ridge National Laboratory (ORNL); Savannah River Ecology Laboratory; United States Geological Survey (USGS); Environmental Protection Agency (EPA); Army Corps of Engineers; National Research Council of National Academy of Sciences; University of California at Berkeley; University of Arizona; University of Michigan; Colorado School of Mines; Bechtel Corporation; Weiss & Associates, Inc.; Geraghty and Miller, Inc.; and HydroGeo Consultants. LBL also contacted the Russian organizations involved in the Chelyabinsk site-specific studies, including the research institutes of the Russian Academy of Sciences, and the Ministry of Atomic Energy of the Russian Federation.

Technical Meeting and Workshop

The establishment of the Russian-American Center for Contaminant Transport Studies was discussed with Russian scientists and with SNL, PNL, ANL, DOE/EM, and DOE Office of Basic Energy Sciences (DOE/BES). An opening ceremony was held on June 1, 1993, attended by DOE/SAN, SNL, PNL, Russian scientists, and the Scientific Consul of the Russian Consulate General. The Center is now recognized as one of the focal points for interaction and cooperation between American and Russian scientists in contaminant migration studies.

An Advisory Committee for the Contaminant Transport Center was formed with Academician N.P. Laverov, Vice-President, Russian Academy of Sciences; Professor Glenn Seaborg, University of California and LBL; Dr. Clyde Frank, U.S. Department of Energy; and Dr. N. Egorov, Deputy Minister, MINATOM as the initial committee members.

The first workshop at the Center included U.S. participants from national laboratories (LBL, LLNL, SNL, LANL, PNL, and Savannah River Ecology Lab), universities (U. of Arizona and UC Berkeley), and the USGS. The Bechtel Corporation also attended as the first private sector participant in the Center's activities. Russian participants came from research institutes that have been working with the Mayak Production Association in the fields of environmental restoration and waste management. Russian organizations represented at the workshop included Moscow State University; St. Petersburg Mining Institute; Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences; and Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of the Russian Academy of Sciences.

Interactions with Russian Consulate, Delegation, and Institutions

Dr. Valery Semin, Scientific Consul of the Russian Consulate General attended the Center's opening in June, the workshop in July, and met the Russian Delegation in September. According to Dr. Valery Semin, this task is "...the first concrete step of Russian-American scientific cooperation after many years of general discussions and plans...It is good to see Russian and American scientists roll up their sleeves and get down to work..."

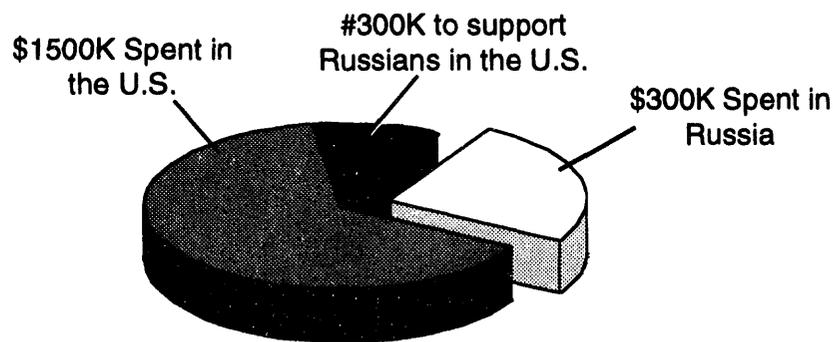
Dr. Chin-Fu Tsang attended the Environmental Training Course for the Russian Delegation in Washington, DC, April 6-9, and presented a lecture on Contaminant Transport Modeling to the delegation. The *Seminar on Remediation of Sites Contaminated by Radionuclides*, was held April 20-22, in Phoenix, Arizona. Dr. Tsang met with Professor V. Mironenko of St. Petersburg Mining Institute, Professor I. Khodakovsky of Vernadsky Institute of Geochemistry in Moscow, and Dr. E. Drozhko of Mayak Production Association at Chelyabinsk to discuss a detailed plan for joint studies, the type of data needs that they will provide, and necessary procedures to establish pilot projects in Russia. Dr. Tsang visited Russia on June 12-15 for discussions with Russian scientists on the problems of contaminant transport in geological media. This visit also included a meeting with Professor N.M. Proskuryakov, Director of the St. Petersburg Mining Institute, and Professor Proskuryakov's research group.

Drs. Eugene Drozhko and Evgeny Kudriavtsev, representing MINATOM, visited LBL on September 27-28. Problem areas were identified, including data analysis and the evaluation of existing test results (data collection processes, comparative studies, etc.); site characterization of the three-dimensional flow systems around Lake Karachai, River Myshelyak, and along the Techa River reservoirs; plume characterization of the three-dimensional migration of different chemical constituents and radionuclides on large and small scales; modeling

of plume migration at the site; alternative conceptual models; and alternative plume remediation strategies, including optimization and barriers (possible design ideas, problems of open wells, etc.).

Pilot Projects in Russia

Three pilot projects at Chelyabinsk, Moscow and St. Petersburg were supported. Dr. E. Drozhko from Chelyabinsk used data from several wells for the determination of hydraulic characteristics of groundwater flow regimes in the strongly contaminated Lake Karachai region. Prof. I. Khodakovsky, from Moscow, studied chemical evolution of artificial reservoirs that have been receiving radioactive contaminant inflows over decades. Prof. V. Mironenko from St. Petersburg developed numerical and analytical models for assessment and interpretation of hydrogeological field tests at key sites in the Lake Karachai area.



\$2.1M total EM dollars spent on Russian programs

Publications of Russian Studies

The work performed by scientists in the Mayak Production Association under the U.S.-Russian agreement will be published in a series of reports for distribution by the Russian-American Center for Contaminant Transport Studies at LBL. These reports will be fully credited to the Russian authors and their affiliations.

The Proceedings for the opening of the Russian-American Center for Contaminant Transport Studies at LBL have been published. Viewgraphs used in the first workshop at LBL have been collected and are included in the proceedings of the Workshop.

The following reports have been drafted and are being reviewed:

Drozhko, E.G., Mironenko, V.A., Pozdniakov, S.P., Samsonova, L.M., Shestakov, V.M. *Previous Investigations and Field Hydrogeological Data for the Chelyabinsk Region.*

Drozhko, E.G., Mokrov, Yu.G., Glagolenko, Yu.V., Samsonova, L.M. *Determination of Hydrodynamic Parameters of Cleaved Rock Mass According to Regime Examination Data in the Lake Karachai Area.*

Drozhko, E.G., Samsonova, L.M., Zinin, A.I., Yinkin, V.P. *Computer Model of Solutions: Unsteady Migration in Groundwater.*

Mironenko, M.V., Y.G., Glagolenko, Drozhko, E.G., Khodakovskiy, I.L., Mokrov, G.Yu., Polyakov, V.B., Smirnov, A.B., Spasennykh, M.Yu. *The Cascade of Reservoirs of the "MAYAK" Plant: Case History and the First Version of a Computer Simulator.*

Mironenko, V.A., Rumynin, V.G. *Analysis of Hydrogeological Consequences of Hazardous Accidents at Designed Nuclear Reactors: Forecast and Field Investigation.*

Mironenko, V.A., Rumynin, V.G., Shestakov, V.M., Konosavsky, P.K., Pozdnyakov, S.P., Roshal, A.A. *Development of Analytical and Numerical Models for the Assessment and Interpretation of Hydrogeological Field tests at the Key Sites of the Lake Karachai Area.*

Pek, A.A., Malkovsky, V.I. *Modeling of Fault-Controlled Hydrothermal Ore-Forming Systems.*

Malkovsky, V.I., Pek, A.A. *Computer Simulation of Nuclear Waste Transport from the Deep Drill Hole Repository: Thermal Convection Model.*

Pek, A.A., Malkovsky, V.I. *High-Level Nuclear Waste Geological Disposal: Utilization of HLW Heat Generation in the Design of Engineering Barriers.*

Pozdniakov, S.P., Shestakov, V.M. *Quasi-3D Variable Density Flow Model.*

Accomplishments

- Five Russian scientists conducted extensive testing and validation of models and data for the Chelyabinsk region at LBL.
- The Russian-American Center for Contaminant Transport Studies was established at LBL on June 1, 1993 to carry out cooperative Russian-American tasks.
- The initial workshop at the Center was held July 7-9, 1993, in Berkeley, California. U.S. and Russian scientists exchanged information and discussed specific case histories, analyses, and modeling techniques of current studies in contaminant transport studies.
- The Scientific Consul of the Russian Consulate General attended the Center's opening and the workshop, and also met the Russian Delegation at LBL.
- Dr. Chin-Fu Tsang met with the Russian delegation in April and visited Russia in June 1993.
- Drs. Eugene Drozhko and Evgeny Kudriavtsev, representing MINATOM, visited LBL in September 1993.
- Three pilot projects in Chelyabinsk, Moscow, and St. Petersburg were initiated.
- LBL established a mechanism for distributing information on Russian studies to U.S. scientists. Ten reports have been drafted and are under review.

EM Cooperative Efforts

This activity is jointly funded by U.S. Department of Energy's Office of Environmental Management – Office of Technology Development and Office of Energy Research – Office of Basic Energy Sciences. This activity has been transferred to the Characterization, Monitoring, and Sensor Technologies Integrated Program.