



Installation Of A Permeable Reactive Barrier In Uranium Mining District – East Central Ukraine

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In the June 2009 USNC newsletter I reported on a USEPA Office of Research and Development project entitled: *Regional evaluation of mining-related metals contamination, risks and innovative remediation technologies in STCU nations: Ukraine and Georgia*. The project was authorized and funded by the U.S. State Department as part of the Bio-chem Redirect Program (BCRP). The BCRP is focused on non-proliferation, anti terrorism and de-mining activities in former Soviet Union countries. The project is being administered by the Science and Technology Center (STCU) in Kiev, Ukraine. One of the key objectives of this project was to pilot the use of an innovative remediation technology for groundwater impacted by mining activities. This article is a follow up to the June 2009 article and reports on the installation and preliminary effectiveness of a permeable reactive barrier installed in October 2011 downgradient of a large tailings facility at a uranium mine near Zhoty Vody, Ukraine.

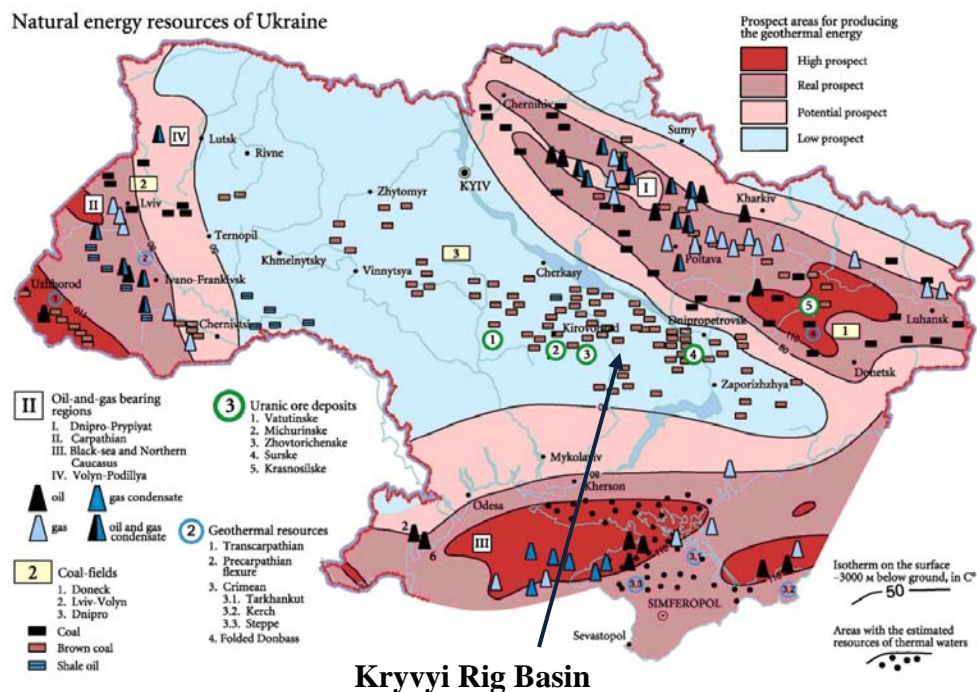
Ukraine, one of the largest of the former Soviet Union countries, has a diverse mining industry that produces a wide variety of metallic and nonmetallic minerals that accounts for a significant part of the county's economic output. The major mining products include iron, manganese, uranium ores, coal, titanium, zirconium, beryllium, sulfur, mercury, non-metallic raw material for metallurgy and potash salt. Ukraine is a leader in Europe and the world with respect to known mineral reserves of: iron ore - 30 billion tons (6% of the world reserves), manganese ore – 2.5 billion tons (22.4%), coal – about 46 billion tons, and pure uranium – 42.6 thousand tons. Mining of titanium ore and production of titanium concentrate in Ukraine accounts for about 20% of the world production (National Report of the State of Environment in Ukraine, 2006). Since the break up of the Soviet Union, the development of mining and processing industries in Ukraine has increased. To accommodate modern understandings related to the environmental and human health risks associated with mining and to better compete in the modern free market the Ukrainian mining industry is starting to recognize the need for environmental characterization and management in mining districts, including remediation of contaminated water resources. Locally, there is significant pollution and degradation of the environment, particularly contamination of water resources, soil, and air near towns associated with past mining practices. The ability of the Ukrainian government and mining industry to reduce the human health risk in large mining districts has been constrained by the economic crisis and implementation of structural changes in the public health care system. The BCRP program is aimed at providing technical assistance to Ukrainian scientists engaged in work related to water resource remediation.

The Kryvyi Rig basin in the east central part of Ukraine (Figure 1) is one of the largest uranium mining districts in Europe. Uranium mining has a long history in Ukraine and occurred throughout the Soviet period. Zhovty Vody is one of the largest cities within the uranium mining district and is a center of uranium and iron ore milling and primary enrichment. Uranium mining and processing (including a hydrometallurgical plant and sulfuric acid plant) is conducted by the state owned enterprise VostGOK. The mining company and the City of Zhoty Vody have partnered with EPA and the Kiev Polytechnic University to install a permeable reactive barrier at a hydrogeologically suitable location to treat groundwater contaminated by leachate from a large tailings facility near Zhoty Vody. The “Shch” tailings facility is located in the Hcherbakovskaya Gully – a right hand tributary to the Zhovta River. The facility, which overlies about 200 ha, is located is about 1.5 km south of Zhoty Vody and about 1.0 km west of the Zhovta River. Liquid and solid process waste is discharged through slurry pipelines into the



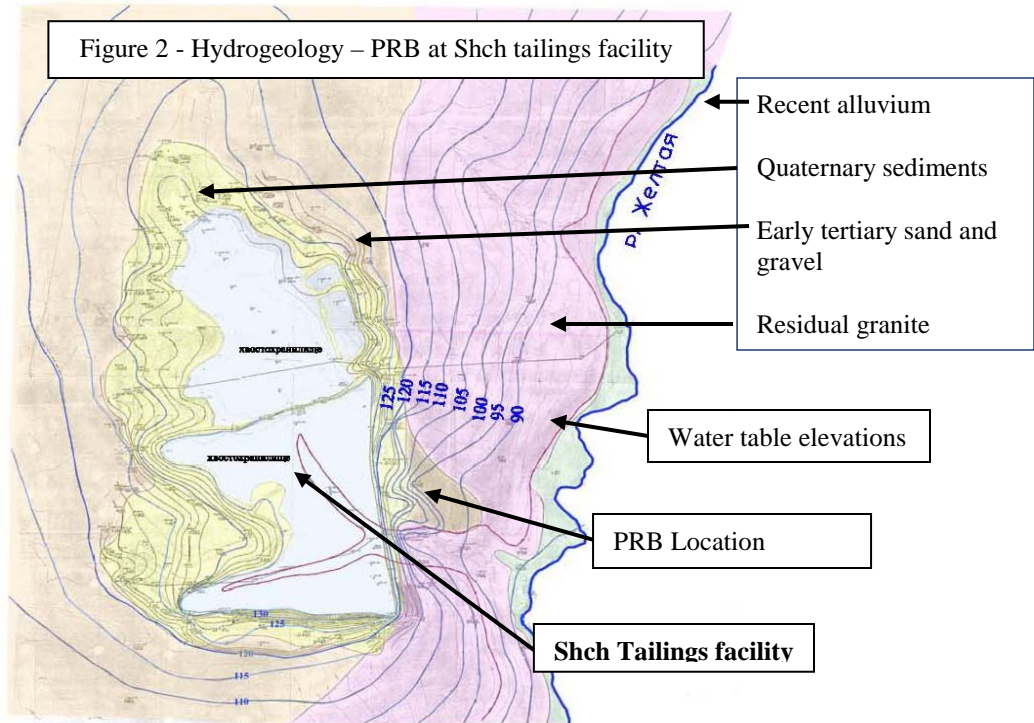
tailings facility. Seepage from the tailings facility infiltrates to the shallow water table which has resulted in contaminated groundwater discharging to the Zhovta River which is used by local residents for domestic and agricultural purposes. Shallow groundwater occurs in an aquifer comprised of unconsolidated Tertiary and Quaternary sediments which overlie a thick residual layer developed at the top of Precambrian granites (Figure 2). This shallow aquifer is about 30 meters thick, and depth to the water table is less than 5 meters. A steep gradient (0.23 -0.4) has developed on the water table as a result of the leachate mound beneath the tailings facility. This results in a fast travel time to the discharge area into the Zhovta River.

Figure 1 – Location of Kryvyi Basin -Ukraine



From 2008 to 2011 field investigations were conducted to characterize the hydrogeology and surface water / groundwater quality in the vicinity of the tailings facility, and determine the most suitable location for the PRB. Concurrently, laboratory bench scale tests were being conducted at the Kiev Polytechnic University to evaluate the effectiveness of different treatment media to be used in the PRB. Groundwater chemistry data for test well C-024, which has been monitored for more than 20 years, are shown in Figure 3. These data indicate that sulphate and TDS concentrations, and uranium 238 activity have increased significantly over that time.

In the summer of 2011 the PRB was installed. A new design of PRB was constructed - cylinders with reactive materials installed in rows - instead of a conventional continuous barrier or a funnel-and-gate setup. The PRB consists of three staggered rows of seven wells, which contain three different treatment media, and 8 monitoring wells. The three different treatment media include: inorganic reactive material (zero-valent-iron) and two biologically active materials. Wells 1-7 were filled with zero-valent iron and sand, wells 8-14 were filled with zero-valent iron, calcium phosphate, sawdust and sewage sludge and wells 15-21 are filled with gravel, calcium phosphate, sawdust and sewage sludge. Water level and water chemistry data are currently being collected under an approved long term



monitoring program. These data are being analyzed to evaluate the effectiveness of the PRB over time. Preliminary results indicate that during the last six month period, the concentration of uranium in the groundwater being treated by the biologically active materials was practically unchanged – perhaps due to the low content of microorganisms in clayey and sandy soil near uranium tailings storage facility. At the same time, the uranium concentration in groundwater treated by zero-valent iron decreased to 0.1mg/liter which may demonstrate the effectiveness of zero-valent-iron as active material for use at contaminated sites in Zhovty Vody region. More data will be collected during the next two years to more fully evaluate the PRB effectiveness.

Figure 3 -Groundwater chemistry – Hole C-024 – PRB

Скважина с-024

