Journal of Environmental Monitoring

Dynamic Article Links

Cite this: *J. Environ. Monit.*, 2012, **14**, 1190

www.rsc.org/jem

PAPER

Uranium series radionuclides in surface waters from the Shu river (Kazakhstan)

Mukhambetkali Burkitbayev,[a] Bolat Uralbekov,*[a] Sholpan Nazarkulova,[a] Ilona Matveyeva[a] and Luis León Vintró[b]

Received 19th December 2011, Accepted 1st February 2012
DOI: 10.1039/c2em11014h

The concentrations of ^{238}U, ^{234}U, ^{226}Ra, ^{210}Po and ^{210}Pb have been determined in surface waters collected along the course of the Shu River, lying on the border between Kazakhstan and Kyrgyzstan. In the study area, the river runs through some of the largest uranium deposits worldwide, which were actively exploited during the nuclear weapons and nuclear energy programmes of the former Soviet Union. The data show an increasing trend in uranium concentrations downstream the river from the city of Tokmak to the city of Shu, with good correlation between total uranium concentrations and total dissolved solids. Data on uranium isotopes disequilibrium show the presence of technogenic uranium inputs into the Shu River downstream from the city of Karasu, evidenced by a decrease in the measured $^{234}U/^{238}U$ isotopic ratio from 1.63 in uncontaminated sites to 1.29 in sites affected by past mining activities.

1. Introduction

Uranium ore mining and milling operations were conducted in the Shu River basin from the mid-1950s as part of the nuclear weapons and nuclear energy programmes of the former Soviet Union. Until the mid-1980s, recovery of the uranium ore was accomplished by mining in underground mines and open pits. Since then, *in situ* methods involving underground leaching by sulfuric acid have been used. During the Soviet period, recovered uranium ores were delivered to the nearby metallurgical industrial complex of Kara-Balta (Kyrgyzstan) for the production of uranium oxide. Thus, the initial steps of the nuclear fuel cycle, from mining to processing, were carried out within a relatively small area along the Shu River basin, on the border between Kazakhstan and Kyrgyzstan.

As a result of these past ore mining and processing activities, large volumes of low-level radioactive waste in the form of spoil heaps and tailing materials were left behind at different sites within this area. Prior to the present work, no comprehensive study had been undertaken to evaluate the radiological impact of these legacy wastes on the waters of the Shu River, with only a limited number of measurements available for sampling sites located close to former uranium ore production facilities. For example, elevated concentrations of uranium have been reported for samples collected from surface waters within the Kurdai deposit site, which is located about 60 km from the Shu River and was the first industrial-scale deposit in Kazakhstan.[1,2] As water from the Shu River is used by local populations for domestic use, irrigation of crops and watering of cattle, an evaluation of the potential radiological consequences arising

[a]*al-Farabi Kazakh National University, Almaty, Kazakhstan. E-mail: bulat.ural@gmail.com; Fax: +7 (727) 2 92 37-31; Tel: +7 705 713 73 49*
[b]*School of Physics, University College Dublin, Belfield, Dublin 4, Ireland. E-mail: luis.leon@ucd.ie; Fax: +353 1 283 7275; Tel: +353 1 716 2221*

Environmental impact

The Shu River, flowing between the borders of Kazakhstan and Kyrgyzstan, runs through one of the largest uranium deposits worldwide. Some of these deposits were actively exploited by the former Soviet Union as part of their weapons and nuclear energy programmes. Decades of mining and processing activities have left large volumes of low-level radioactive waste in the form of spoil heaps and tailings, which now represent a route of potential contamination to the river waters. The present study looks at the concentrations of uranium and other nuclides from the uranium series in surface waters collected along a stretch of the river passing through these legacy wastes and, making use of uranium isotopic ratios, assesses the contribution from various potential sources to the measured concentrations. The dosimetric implications arising from the hypothetical consumption of these waters (drinking pathway) are discussed and compared with the limits set for drinking water by the WHO.