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Speciation and source identification of U from contaminated TENORM sites

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Following the cold war, extensive uranium mining and production took place at selected sites in Kazakhstan and Kyrgyzstan.as a vital part of the nuclear weapon program in the former Soviet Union. The uranium deposit situated in the Southern Kazakhstan and the adjacent territory of Kyrgyzstan contains about 15 % of the world reserves of uranium. The deposit represents an area of roughly 60 000 km^2. The full industrial cycle of uranium recovery and processing of uranium ores have been undertaken in this region for about 50 years. Moreover, all types of uranium recovery have been undertaken: open-cast extraction; underground mining; in situ leaching with pumped sulphuric acid solutions. This densely populated territory was an administratively “closed area” within the USSR and information of the ecological state of this region is limited. Results available suggest that significant ecological damages, including radionuclide contamination and chemical pollution have occurred. Moreover, serious medical-pathological problems within the local population have been reported and these are claimed to be related to the environmental situation. Consequently, the Governments of Kazakhstan and Kyrgyzstan, and IAEA have expressed their concern about the radioecological situation within this region.

The present paper focuses on the speciation, mobility and source identification of uranium from 2 sites in Kazakhstan and Kyrgyzstan contaminated with technologically

enhanced naturally occurring radioactive material (TENORM). U in TENORM particles have been characterized using Environmental Scanning Electron Microscopy with Energy Dispersive X-ray analyser and synchrotron radiation based scanning micro-x-ray fluorescence (XRF)/micro- x-ray diffraction (XRD) to obtain information on the solid state speciation and hence potential mobility of U from minerals. Furthermore, at site size and charge fractionation techniques (0.45 μm filtration and 10 kDa hollow fibre ultrafiltration system interfaced with ion chromatography) were applied to surface and groundwaters and analysis were performed using mass spectrometry (ICPMS and AMS) analysis on obtained fractions (ionic species, colloids and particles) to provide information on the speciation and migration of U in water.

Results from micro-XRF/micro-XRD of particles from the sites show that a major fraction of U in the investigated mineral grains was present in relatively soluble minerals (U(VI)). Thus, the potential mobility of U at these sites should be considered relatively high. The concentration of U in water is also higher than the international requirement level (EPA). The ^{234}U/^{238}U ratio can also be utilized to characterize the influence of anthropogenic activity downstream.