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Polycyclic aromatic hydrocarbons (PAHs) in soils, water sediments and post-flotation wastes in Kitwe region (Copperbelt, Zambia)

Wolkowicz, S.¹, Nyambe, I.², Bojakowska, I.¹, Biel, A.¹, Chirwa, M.²

¹Polish Geological Institute-NRI; Warsaw, Poland. stanislaw.wolkowicz@pgi.gov.pl

² University of Zambia, Lusaka, Zambia

The Copperbelt is one of the *world's* largest metallogenic provinces. Stratiform Cu-Co deposits of that region are related to SE end of the Lufilian Arc. Host rocks for Cu-Co ores are represented by shales and arenites of the sedimentary Roan Group, the lowermost unit of the Katanga Supergroup. *Large-scale mines* and *ore processing* facilities started in 1930s and turned that region in one of the largest centers of copper production in the world. This resulted in construction of tailing dams to collect and store tailings for each mine area within the Kafue River drainage basin. This mining led to population growth and urbanization resulting in towns such as Chingola, Mufulira and Kitwe without an adequate water and solid waste management. These studies are based on water sediments and soils collected from floodplains and terraces of the Kafue River and its tributaries upstream and downstream of the Mufulira and Kitwe mining regions. Three samples were taken for laboratory analyses at each of 11 profiles: one sample of water sediments and two samples of soils from floodplain, from 0–30 cm depth at points about 5 and 15 m distant from river banks. Further, 7 samples of flotation wastes deposited in settling ponds localized in Chingola, Chambishi, Kitwe (Mindolo, Nkana) and Ndola Bwana Mkubwa were also collected. These samples were analyzed for the content of 17 PAHs: acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[e]pyrene, benzo[a]pyrene, perylene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[ghi]perylene. The highest values of the PAHs were in water sediments of the Uchi Stream, where the levels of acenaphthylene were about 602 µg/kg, benz(b)fluoranthene – 1,609 µg/kg and those of dibenz(a,h)anthracene - 363 µg/kg. These levels are higher than their probable effect concentration (PEC). PAHs levels detected in the remaining places are lower than threshold effect concentration (TEC) [1]. In turn, sum of PAHs recorded in water sediments of Uchi Stream equals 12,567 µg/kg and peak values of all the pollutants listed above come from that locality. Similarly, Uchi Floodplain soils yielded several compounds of the PAHs group in concentrations much above levels admissible for soils used in agriculture. Total sum of PAHs recorded in floodplain soils equals 12,692 µg/kg and in those of first terrace – 17,811 µg/kg. High concentrations of PAHs were also found in soils of terraces of Mufulira Stream, where the sum of PAHs is equal to 6,842 µg/kg in soils of the floodplain, 3,873 µg/kg in those of the terrace, and 1,016 µg/kg in water sediments. In the remaining tributaries of the Kafue River, sum of PAHs for water sediments is below 1,000 µg/kg. For floodplain soils it ranges from 100 to 500 µg/kg rising up to 1,871 µg/kg only in the case of floodplain soils of the Mwambashi Stream at Kitwe. The analysis of levels of PAHs in water sediments of Kafue River range from 118 µg/kg, 167 µg/kg to 581 µg/kg and these seem to emanate from the right-bank tributaries of the Kafue River. High concentrations in terrace soils may be explained in terms of wash out of these pollutants during rainy season and their entrapment in a broad flood plain zone covered with luxuriant vegetation. The contents of studied PCBs in the post-flotation wastes deposited in tailing dams are low. A relatively highest content were found for phenanthrene (up to 202 µg/kg), fluoranthene (up 87 µg/kg) and pyrene (up to 72 µg/kg). PAHs contents in sediments of streams draining residential areas are several times lower which suggests that urban factors (motorization, small and medium

industries and services, improper management of waste including uncontrolled open waste burning appear to be of secondary importance as a source of PAHs pollution. The studies showed that post-flotation tailings, both active and abandoned, are the major source of pollution of water sediments and soils of floodplains of Kafue River and its tributaries in the Mufulira/Kitwe region. The highest concentrations of PAHs were recorded in the neighborhood of such deposits whereas residential area sediments and water have lower PAHs.

References:

[1] MacDonald D.D. et al. (2000) Arch Environ Contam Toxicol 39: 20-31

