Mercury Methylation/Demethylation Potentials in Soils from Idrija Hg Mining Area, Slovenia, Studied using $^{197}Hg^{2+}$, $CH_3{}^{197}Hg^+$ and $^{14}CH_3Hg^+$ Radiotracers

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Abstract: The aim of our work was to investigate methylation and demethylation potentials of soils from Idrija Hg mining area, Slovenia. Methylation of Hg^{2+} results in $MeHg^+$, a high neurotoxin, - this process was studied using $^{197}Hg^{2+}$ radiotracer. Demethylation process (detoxification) of CH_3Hg^+ results either in formation of CH_4 and Hg^0, known as a reductive demethylation, or in formation of CO_2 and unidentified Hg moiety, known as an oxidative demethylation. The transformation was studied using $CH_3{}^{197}Hg^+$ and $^{14}CH_3Hg^+$ radiotracers. The latter was used to follow the formation of gaseous products ($^{14}CH_4$ and $^{14}CO_2$), which indicates the prevailing detoxification mechanism mentioned above.

In this work, the following soil samples were investigated: IAEA Soil-1 (dried, sieved and homogenised soil, a candidate for RM, sampled from a floodplain about 40 km downstream Idrija, just before Idrijca River merges Soca River), Baca soil (fresh soil from the sampling point of Soil-1) and chimney soil (sampled at the Hg ore smelter chimney in Idrija). In addition, we tested sediment from Hg non-polluted area (Ljubljana wetland). Samples were spiked with radiotracers of high specific activity and incubated in dark for up to several days at room temperature and mostly under aerobic conditions. $Me^{197}Hg_+$ (-formed in methylation experiments and remained fraction in demethylation experiments) was acid-leached from the samples and extracted into toluene, which was subsequently measured on well-type HPGe detectors. The gaseous products from $^{14}CH_3Hg^+$ demethylation were trapped in NaOH solution and counted on liquid scintillation counter after the addition of scintillation cocktail. CH_4 was combusted to CO_2 in CuO column at high temperature prior to trapping in NaOH solution.

The results obtained show no net methylation potential in the samples studied. On the other hand, the fractions of demethylated $MeHg^+$ added to the samples were high, ranging from few percent up to 40% at the most contaminated site. ^{14}C-radiotracer studies suggest reductive demethylation in soil, as the oxidative reductive demethylation potential ratio was about 0.1. This finding indicates the presence of Hg-resistant microorganims which demethylate $MeHg^+$ encimatically after the induction of mer (mercury resistance) genes.

Key words: soil, radiotracers, Hg transformations