EGU2020-5488
https://doi.org/10.5194/egusphere-egu2020-5488
EGU General Assembly 2020

Mercury occurrence in shungite and coal

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Shungite is a mineraloid consisting of up to 99 % of carbon. The first deposit was found near Shunga village (Karelia, Russia) within the Paleoproterozoic host rocks. Karelian shungites represent the greatest accumulations of carbon with reserves of up to one billion ton. Shungite matter is considered as a specific allotrope of carbon having complex globular supramolecular structure with the globules size of 5-10 nm and including 0.0001 – 0.001 % of natural fullerenes. There are two opposite opinions on the shungite origin: the deep metamorphism of the organic-rich sedimentary rocks and the pyrolysis of the mantle methane jets. In its properties, shungite occupies an intermediate position between anthracite and graphite. Mercury in coals is quite fairly studied: according to hundreds thousand analyses, the average mercury content varies in a range from ppb to few hundred ppm with a world average of 100 ppb. In contrast to coal, so far almost no data on mercury in shungites are available.

Zeeman AAS was used for determination of the total mercury concentration in shungites from Karelian shungite deposits. Surprisingly high concentration up to 12,000 ppb with an average of 2200 and median of 1100 ppb was found in all samples. That is much higher than world average value and even three times higher as compared with the mercury concentration in studied coals of the Donetsk basin (450 ppb) located within the mercury belt. The thermoscanning technique revealed a high-temperature form of mercury in shungites releasing at a temperature above 650 ^{O}C and comprising 40-45% of the total mercury. That drastically differs from the thermospectra of anthracite with the main portion of mercury being released at a temperature below 480 ^{O}C. The loss of mass for anthracite and shungite during heating to 900 ^{O}C is practically identical, whereas the loss of mercury from anthracite is much faster. As both substances consist mainly of carbon, the difference in mercury binding energy can be explained by a specific globular structure of the shungite matrix. Additional experiments on the shungite exposure to mercury in the liquid and gaseous phases showed the increased mercury release at a low temperature and no increase in the high temperature species. The occurrence of a significant portion of the uncommon high temperature species suggests that this mercury can be transported with the mantle methane jets and captured inside the stable carbon globules of the shungite.

Preliminary assessment of the mercury resources only for three proven deposits (54 million ton of shungite, Filippov, 2002) gives the value of 55 t Hg. Shungite is widely used in ferrous metallurgy, for water purification, in cosmetology, etc. Shungites have to be considered as a potential source of the mercury emissions in metallurgy. Also, shungite mercury behavior in other industrial,

ecological, medical, and cosmetology applications should be studied.