Thallium in brown and hard coals of Poland

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Introduction

Main anthropogenic source of thallium in the environment is high-temperature processing of raw materials, in which it occurs at small concentrations.

Material and methods

Concentration of thallium and Ag, Cu, Pb, Rb and Zn contents have been determined in 214 samples of brown and hard coals with the ICP-MS spectrometry. Hard coal samples were collected from Carboniferous in Upper Silesia (USCB), Lower Silesia (LSCB) and Lublin Coal Basins (LCB) areas, and brown coal samples were collected from mined deposits in Poland – Turów, Bełchatów, Koźmin, Lubstów, Adamów and Kazimierz.

Results

Contents of thallium in brown coals ranges from 0.2 mg/kg (detection limit) to 2.4 mg/kg. It was noticed that coals from Bełchatów and small town Adamów-Konin region deposits - Koźmin, Lubstów, Adamów, and Kazimierz characterize very low concentration of thallium. In these coals Tl contents not exceed 0.4 mg/kg and average contents is <0.2 mg/kg. Turów deposit coals distinguish by increased Tl contents. Thallium concentrations in brown coals from theses deposits average 0.7 mg/kg. Distinctly higher Tl contents in Turów deposit coals are caused by overall lithology of the sedimentation basin and its alimentation area and may be connected with cropping up granites and granitoids of crystalline basement and Tertiary alkali basalts. High correlation between Tl and Rb concentrations in brown coals was observed.

Contents of thallium in hard coals ranges from 0.2 mg/kg to 5.3 mg/kg. Samples of hard coals from USCB characterize higher thallium concentration in comparison to two others coal basins. Average concentrations of that element in USCB coals is 0.5 mg/kg, whereas in samples from LCB is 0.4 mg/kg and in samples from LCB is 0.3 mg/kg. Our results shows diversification of thallium contents in coals from USCB. The highest concentrations were observed in coal from upper seams of SE part of the deposit. They might be connected with Zn-Pb (and Fe sulphide) mineralization in Triassic dolomites overlying this part of USCB. In these coals the high correlation between Tl and Pb contents was observed, and somewhat smaller correlations were noticed with Ag, Cu and Rb.

Conclusion

Obtained results permit to estimate that about 60t/a of thallium are excavated with hard and brown coals in Poland.

Hydrogen abundance in the prebiotic atmosphere. Reducing or weakly reducing?

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The atmospheric hydrogen abundance was crucial for the organic synthesis on the prebiotic Earth. For decades a common assumption of the fast (diffusion-limited) hydrogen escape lead to a belief that the prebiotic atmosphere had to be weakly reducing and therefore organic synthesis should have occurred only in the special locations such as hydrothermal vents.

However, the recent study of the hydrodynamic hydrogen escape from the anoxic hydrogen-rich planetary atmospheres suggested that hydrogen could have been lost at a very slow rate and a hydrogen-rich (reducing) prebiotic atmosphere could have been maintained by a reasonable volcanic hydrogen source. This calculation was incomplete though because we did not show how the atmosphere could get to the hydrogen-rich state in the first place.

Here we will report on the atmospheric conditions under which the hydrodynamic escape had to occur. We found that the switch between the reducing and weakly reducing atmosphere was a strong non-linear function of the ancient solar ultraviolet (UV) flux.

UV fluxes > 5 times the present UV flux favor the fast diffusion-limited escape and cause the atmosphere to be weakly reducing. UV fluxes < 3 times the present UV flux always result in a slow hydrodynamic escape and the hydrogen-rich atmosphere should be expected. We conclude that the rate of the organic production on the prebiotic Earth could have been directly dependent on the evolution of the UV flux of the ancient Sun.

We will also report on how the rate of the hydrogen escape would have changed when the first biosphere would provide a significant methane source in the Archean atmosphere.