Geochemical hazard by coal-ash from a coal-based thermal power plant in Kolaghat, West Bengal, India

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Introduction

Coal combustion of thermal power plants in India is a major source of environmental pollution due to the generation of huge amounts of ash rich in toxic and radioactive elements, which are disposed off in large ponds and on open grounds surrounding the power plant. Absence of an underground lining permits easy mixing of the ash with the top soil of the area. Geochemical and radionuclide study of coal, ash, water and soil was carried out around a major thermal power plant in India to assess the potential contamination of the soil and the groundwater system.

Experimental methods

Major, minor and trace elements in the ash, coal and soil samples around the ash ponds of the power plant by x-ray fluorescent spectrophotometer. ICP-MS was used to determine the concentration of the trace elements in the water samples collected from the wells located near the vicinity of the ash ponds and in the surrounding villages of the study area. NaI (Tl) induced gamma-ray spectrometer.

Results and Discussions

Major and minor oxide analyses of the coal and ash document predominance of silica and alumina. The coal-ash is significantly enriched in the trace elements Pb, Cu, Ni, As, Cd, Cr, V, Mo etc. Radiometric analysis of the ash shows that the radionuclides (U^{238}, Th^{232}) are enriched 3-5 times in the coal ash as compared to their crustal average. The average absorbed gamma dose rates at 1m above the ground from the ash ponds due to the presence of Th, U ^{0}K is 160 nGy h^{-1} which is ~4 times higher than the world average(43nGyh^{-1})as reported by UNSCEAR (2000).Chemical analysis of the water samples show siginificant concentration of the trace elements (Al, Ni, Fe, As, Zn, Co, V, Mo, Ba, Rb, Pb V, Cr, Cu, Cd, Mn and Sr) whose distribution is mainly controlled by the ash deposited in the area. Among these elements, Al, As, Zn, Mo, Ba, V, Mo, Cd, Mn, and Pb exceed the WHO guidelines for drinking water in the tube well waters, near the ash pond than those of the neighbouring villages implying significant input from the ash pile. Chemical and radiometric analysis of the soil samples show enrichment of the trace elements Mo, As, Cr, Mn, Cu, Ni, Co, Zn, by a factor of (2-5) than the crustal values.

Combustion of coal thus causes serious environmental concern due to the release of the toxic trace elements and the radionuclides in the ash, thus contaminating the top soil and the subsurface aquifer. People living near the ash ponds are subjected to a high radiation dose from the ash ponds and the soil cover, which is ~ 2.6 times higher than the world average.

Temperature-dependent molecular cell membrane adaptation of microbial populations in Siberian permafrost

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Permafrost is a common feature in polar regions. The uppermost permafrost layer, thawed in summer, is characterized by an extreme temperature regime from about +15°C to –35°C. Even so a diverse range of microorganisms have been discovered in this so-called active layer.

The aim of the current study was to examine as to how the microbial populations within the different horizons of the active layer were adapted to the extreme variable temperature regime of the permafrost area. Thus, two soil samples were taken from the active layer on Samoylov Island in the central Lena Delta, Siberia: one surface-near sample (11-18 cm) and one permafrost-near sample (25-32 cm). Aliquots of each sample were incubated under 4 °C and 28 °C for about 4 weeks. Subsequently, the molecular cell membrane composition (phospholipids) was qualitatively and quantitatively evaluated using HPLC-ESI-MS/MS.

To maintain the membrane fluidity at low temperatures, microbial cells can decrease their solid-liquid phase transition temperatures below the ambient temperature. They change their phospholipid fatty acid composition to more bulky-shaped cis-unsaturated fatty acids and/or to more shorter-chain fatty acid, because of the lower melting temperatures of unsaturated and shorter-chain fatty acids.

The comparison of the phospholipid fatty acid (PLFA) distribution of the different horizons at 4 and 28 °C shows that the microbial population of both horizons does not incorporate significantly more unsaturated fatty acids under cooler conditions. In contrast to this the surface near as well as the permafrost near microbial communities reveal for both a distinct relative increase of short chain fatty acids of 7.3 and 10.3% in the 4 °C incubation experiment.

In addition to this distinct chain length adaptation, the PLFA proportions of the microbial population of the active layer differ with the different depth horizons. The permafrost near microbial community shows, in general, a higher relative proportion of unsaturated and shorter chain fatty acids. This indicates a stronger adaptation to cooler environmental conditions, whereas the surface near population reveals a higher flexibility towards warmer temperature conditions.