



Cold-condensation of PAH in soil of the European Alps (Martell valley)

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Atmospheric deposition represents a main source of polycyclic aromatic hydrocarbon (PAH) contaminating top soils at various spatial scales. Due to long range transport PAHs can be found even in remote areas. Recent research states that persistent organic pollutants (POP), such as PAHs, tend to accumulate in high mountain areas due to their physical and chemical properties and the low temperatures. These accumulation processes are summarized as "cold condensation". POPs are emitted in relative moderate areas and precipitate in cooler environments, such as the arctic or high mountain areas: condensation with altitude or latitude as a function of temperature. Recent reports show that especially highly volatile compounds, such as organochlorine compounds accumulate continuously in high mountain areas due to cold condensation. Based on their vapor pressures the PAHs can be divided into semivolatile and non-volatile compounds. Therefore, "cold condensation" should affect the semivolatile PAHs prior to the non-volatile ones. Yet, only few reports deal with cold condensation of PAHs and their accumulation in soil in high mountain areas. This report presents results of an investigation of PAH concentrations in top soils as a function of altitude in the European Alps. The Martell Valley in the northern Italian Alps was chosen as a study site. It is located in the oldest European National Park "Stilfser Joch". Direct anthropogenic impact on soil quality (e.g. due to tourism or industrial sites) is low, atmospheric deposition is the main pathway for PAH entering the soils. The entrance of the valley is at an elevation of 800 m a.s.l.. The highest peak (Mount Cevedale) is at 3770 m a.s.l.. Several samples were taken from top soils during summer and autumn, freeze dried and analyzed for 16 EPA-PAHs. The sample locations were chosen from various altitudes throughout the valley in order to investigate the role of altitude for the top soil PAH concentration. Several samples were taken from the valleys Ötztal and Brand-

nertal as references. PAHs occur in all samples. Soil concentrations range between 1 - 1230 $\mu\text{g}/\text{kg}$ (sum of 16 PAHs, without Naphthalene, referred to dry weight: mean 140 $\mu\text{g}/\text{kg}$, median 50 $\mu\text{g}/\text{kg}$). Samples from the vicinity of 2 villages (close to roads) showed the highest concentrations. PAH soil concentration and organic carbon content (Corg) show a good correlation. Corg is not clearly correlated with altitude. Corg and altitude are positively correlated with PAH soil concentration. If the PAH soil concentration is normalized to the Corg, then topsoil samples from higher altitudes indicate the highest PAH contamination. The concentration increase by a factor of 10 is very likely due to cold condensation and cannot be explained with a higher deposition rate (higher precipitation, factor of 2) with altitude. This finding is in good agreement with results from a study on organochlorine compounds in the Canadian rocky mountains, where a steep increase of concentration is indicating cold condensation phenomena.