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Hot spot formation of chloroform in forest soils caused pollution of groundwater

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High concentration of chloroform in groundwater is usually attributed to anthropogenic input, but we have found that the groundwater beneath some pristine areas contained chloroform from 1 - 10 μg/L. Groundwater containing chloroform that exceeds 1 μg/L could not be used for drinking water according to Danish regulations. The strict demands on groundwater quality may have to be taken into account when decisions are made regarding the change of land use in order to protect major recharge areas from pollution with nitrate and pesticides resulting from high-yield agriculture production. The terrestrial environment and especially hot spots in forest soils seem to be important contributors to apparent pollution of groundwater with chloroform. We performed a field study to investigate concentration and fluxes of chloroform to the groundwater from in four coniferous forests in order to increase knowledge on the hot spot formation and fate of natural chloroform.

We investigated four stations over a period of several years in order to measure the net-formation of chloroform. Field measurements soil air concentrations of chloroform were monitored in five soil profiles down to the groundwater table. Meteorological data were recorded at all stations

In the hotspots up to 120 ppbv was found in soil air under the spruce forest, to be compared to an ambient atmospheric concentration of 0.02 ppbv. The concentration of chloroform in soil air showed seasonal variation with a maximum in August-September. The chloroform concentration decreased with depth in all profiles during the summer half-year to about 20 % of concentration in the production layer. However, the concentration is still high enough to give an equilibrium concentration in the upper groundwater of 1-10 μg/L. Stable carbon isotopic analyses of chloroform from the uppermost groundwater in different parts of the forests and from soil water showed values from δ13C = –13 ‰ to –27 ‰ corresponding to the ratio in natural organic materials and quite different from those of industrial products and from contaminated groundwater (δ13C = –46 ‰ to –63 ‰. The aquifers are in fluvio-glacial sands with few layers of silt and a groundwater table from 4 to 7 m below the surface. In the shallowest parts of the aquifer, the groundwater has chloroform concentrations 0.1 to 5 μg/L, and the groundwater is oxic with an age from 5 to 45 years using CFC-dating.

Due to diffusion from the soil air to the atmosphere only a minor part, estimated to about 10-15 % of the produced chloroform will reach the groundwater at 3-5 meters depth. Measurements in a groundwater transect in one of the forest areas indicated that anoxic conditions in the groundwater depleted chloroform totally. Based on the concentrations of chloroform which has been measured in water wells at the waterworks downstream of the forests must it be concluded that the number of hot spots is significantly and can be a supply problem.