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Chloroform production in spruce forest soils - A potential problem for groundwater use in drinking water supply in Denmark

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Groundwater containing chloroform in excess of 1 microgram per litre cannot be used for supply of 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.

A high level of chloroform in groundwater is usually considered to be due to human activity, yet, data from the literature indicate that natural production of chloroform may contribute significantly in some cases. Therefore, studies were initiated by a major water works in the Viborg county, Denmark in order to investigate whether problems regarding chloroform in a number of water wells were due to natural production of chloroform in the recharge area.

The investigations included mapping of chloroform concentrations at various levels in the unsaturated zone as well as in groundwater in different parts of the recharge area representing different land use. The mapping clearly indicated that natural production of chloroform could well be the cause of the chloroform pollution of the water wells. In addition, stable carbon isotopic analyses on chloroform from water wells and multilevel monitoring wells in different parts of the recharge area gave results within the same range of values δ^{13}C = –13 per mille to –27 per mille, quite different from those of industrial products (δ^{13}C = –46 per mille to –63 per mille. Thus, isotopic results support the hypothesis that, chloroform pollution in the area is due to natural

production. The fairly large range in isotopic values of natural chloroform may in part be due to partial degradation under more reducing conditions deeper in the aquifer. A gradual carbon-13 depletion, δ^{13}C = –20 per mille to –27 per mille, with depth, 7 – 44 m, was observed in one 5 level monitoring well. In addition, CFC age-dating of groundwater together with chemical analyses showed that no chloroform was present in older anoxic water, most likely due to complete degradation by microbes.

Chloroform production in undisturbed soil samples was measured in the laboratory, showing that the largest production occurred in soils from a spruce forest. Very minor chloroform production also occurred in soils of a beech forest and soils from a grass field. The laboratory measurements were thus in agreement with the results of previous field measurements in the unsaturated zone below different types of vegetation in the recharge area.