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Investigating the origin of organic carbon in groundwater at a landfill facility

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At an urban landfill facility located in central Italy, we investigate the processes leading to moderate amounts of VOC in groundwater, particularly benzene slightly exceeding the established national threshold value for unpolluted groundwater at one downgradient monitoring well. The landfill is located above a Pleistocene thick lacustrine sequence with clay, silt and sandy levels rich in peats and organic matter, with a local N to S groundwater circulation.
The research question is how far landfill gases (i.e. methane) might migrate from the landfill to the aquifer carrying additional compounds including VOC.
Periodical groundwater monitoring campaigns have been conducted since 2016 at the site. Field parameters (T, EC, pH, DO, ORP) are measured with probes in a flow-through cell. Groundwater sampling is performed with an in-line device in order to minimize sample disturbance. Lab analysis are performed for major and trace elements, DOC, PAH, PCB, VOC. Ammonia is measured in the field with a portable UV-VIS. Environmental isotopes (d18O, d2H, Tritium, d13C) have been assessed twice. Samples for dissolved methane have been collected in three wells in the September 2018 campaign. Further, core samples from selected wells were analysed through total digestion for As, Fe, Mn, among other, and TOC.
Groundwater mostly has an anoxic facies and reducing conditions, less pronounced in the NW side. PAHs were below the detection limit in all monitoring wells while traces of VOCs were found in all the points, with a small exceedance for benzene at one downgradient well. Environmental isotopes suggest that groundwater is fed by rainfall infiltration processes with long residence time (for the low 3H values), except for the well with benzene above the national bound. In this well 13C has a less negative value (suggesting a different carbon source) and 3H has a slightly higher value (indicating younger waters). In addition, DOC and dissolved methane in this well resulted higher than at the others (3.05 mg/L and 0.2 mg/L respectively). Total organic C in the analysed sediments ranges between 0.3 and 9% showing the availability also of geogenic organic carbon. While the landfill managers have already ameliorated the existing gas extraction system, a new sampling campaign for dissolved gas in groundwater is planned at all the points to further investigate on the possible interference of landfill gas with groundwater.