Geophysical Research Abstracts, Vol. 5, 07852, 2003

STABLE ISOTOPES OF WATER AS A NATURAL TRACER FOR INFILTRATION INTO URBAN SEWER SYSTEMS

O. Kracht (1), M. Gresch (1), J. de Bénédittis (2), V. Prigiobbe (3), W. Gujer (1)

(1) Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Dübendorf (Switzerland), (2) Lyon National Institute of Applied Sciences (INSA), Lyon (France), (3) Water Research Institute of the Italian National Research Council (IRSA-CNR), Rome (Italy) (e-mail: oliver.kracht@eawag.ch)

An adequate understanding of the hydraulic interaction between leaky sewers and groundwater is essential for the sustainable management of both sewer systems and aquifers in urbanized areas. Undesirable infiltration of groundwater into sewers can contribute over 50% of the total discharge and is detrimental to treatment plant efficiency. On the other hand, in many European cities groundwater surface levels seem to be particularly controlled by the drainage effect of permeable sewer systems. However, nowadays methods for the quantification of these exchange processes are still subject to considerable uncertainties due to their underlying assumptions. The frequently used assumption that the night time minimum in the diurnal wastewater hydrograph is equal to the "parasitic discharge" has to be reconsidered to today's patterns of human life as well as to the long residence time of wastewater in the sewer networks of modern cities.

The suitability of stable water isotopes as a natural tracer to differentiate the origin of water in the sewer ("real" wastewater or infiltrating groundwater) is currently investigated in three different catchment areas. The studies are carried out within the framework of the European research project APUSS (Assessing Infiltration and Exfiltration on the Performance of Urban Sewer Systems):

1) The village of Rümlang (Zürich, Switzerland) is predominantly served with drinking water from the Lake Zürich. A large fraction of the lakes water is derived from precipitation in the Alps. This drinking water represents the intrinsic provenience of

the wastewater with an δ^{18}O value around -11,5 per mill and δ^{2}H value around -82 per mill vs. SMOW. In contrast, the local groundwater is originating from precipitation in a moderate altitude of about 450 m above sea level and shows comparatively enriched mean δ^{18}O values of -9,7 per mill and δ^{2}H values of -70 per mill with only small natural variations.

The isotopic separation between these endmembers is basically sufficient to estimate the ratio of infiltrating water in the sewer. Uncertainties yet derive from varying amounts of local groundwater in the water supply mains. These will be substituted by additionally purchased lake water in the next experimental stage.

2) The experimental site Toraccia (suburb of Rome, Italy) obtains drinking water from the Peschiera springs group that is situated in the central Apennines chain about 90 km north east of Rome. This spring water is transported to Rome by an aqueduct. A first campaign revealed an average mains water δ^{18}O value of -8,4 per mill and δ^{2}H value of -53 per mill. Potential sources of infiltration are occurrences of perched groundwater. These appear to be enriched compared to the drinking water about 2 to 3 per mill in the δ^{18}O and 10 to 20 per mill in the δ^{2}H value, but show disadvantageous strong variations.

3) Investigations in the urban area of Lyon (France) benefit from the isotopic differences between underground waters originating from the two rivers Rhone and Saone and their associated alluvial aquifers. The oxygen isotope composition of the Rhone water is roughly 3 per mill lighter than that of the river Saone, due to the large differences in the mean altitude and topographic situation of their catchment basins. Considerable amounts of mains water are extracted by production wells in the Rhone aquifer. In consequence a usable difference in the oxygen isotope composition between wastewater and local groundwater of about 1.5 per mill is available for application studies in certain parts of the city.