**Waste water-derived xenobiotics in German tap water: A case study of anthropogenic Gd in tap water and softdrinks in Berlin, Dresden, Düsseldorf, Essen, Karlruhe and Munich**

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Xenobiotics (e.g., pharmaceuticals) and high-tech metals have become emerging microcontaminants in the hydrosphere. We focus on the distribution and behaviour of rare earth elements (REE), especially gadolinium (Gd), in tap water of Berlin, Dresden, Düsseldorf, Essen, Karlsruhe and Munich. First reported in German rivers in 1996, microcontamination of surface waters with anthropogenic Gd has become a common feature in industrialized countries with highly developed health care systems. Anthropogenic Gd is derived from Gd-based contrast agents used im magnetic resonance imaging (MRI). These Gd-based contrast agents are injected into the blood stream and are released from the body via the kidneys within 48 hours. Due to their high stability and water-solubility, Gd-based contrast agents cannot be removed in waste water treatment plants and, hence, are transferred to surface and ground waters, and eventually into tap water. Anthropogenic Gd, therefore, is a tracer for waste water-derived substances some of which may have a high (eco-)toxicity.

An initial study from 2009 compared REE concentrations in tap water in western and eastern districts in Berlin, Germany. Shale-normalized REE patterns in tap water show large anthropogenic Gd anomalies in the western districts, whereas the eastern districts do not show anomalous Gd enrichment, indicating the absence of waste water-derived substances, such as pharamceuticals and personal care products. Considering increasing anthropogenic Gd concentrations in the Havel River over the last two decades and long migration times from the river to the groundwater in the range from month to years, it was predicted that anthropogenic Gd concentrations would increase in the near future and, indeed, between 2009 and 2012 the anthropogenic Gd concentrations in West-Berlin tap water show a significant increase. Considering that improved analytical methods and protocols have become avaiailabe, that include all the new Gd-based contrast agents on the market, this situation should be monitored and the status report should frequently be updated.

We also present new data on REE concentrations in German tap water from Dresden, Düsseldorf, Essen, Karlsruhe and Munich. All tap water analyses show pronounced anthropogenic Gd anomalies in the shale-normalized REE patterns in tap water. We conclude that waste water-derived microcontamination with anthropogenic Gd (and hence possibly other pharmaceuticals and personal care products) is not only restricted to tap water of the western districts of Berlin, but rather is a national-wide phenomenon. In Germany, fast food restaurants such as McDonalds and Burger King use treated local tap water together with a syrup provided by Coca-Cola Company to mix softdrinks on-site. We studied Coca-Cola from MacDonalds and Burger King in German cities and in each case where tap water carries anthropogenic Gd we found the corresponding Gd in the softdrink, indicating that tap water treatment in the restaurants did not remove the Gd-based contrast agents.