Geophysical Research Abstracts
Vol. 17, EGU2015-2359, 2015
EGU General Assembly 2015


# A new method for the determination of Gadolinium in ppq levels

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The use of Gadolinium (Gd) complexes as a contrast agent in Magnetic Resonance Imaging (MRI) results in an enhanced Gd input in the aquatic environment. Gd-complexes are excreted by humans unmetabolized within 12h after application. Passing the sewage systems with almost no degradation taking place, they successively reach surface waters, which make Gd a capable tracer for surface water/groundwater (SW/GW) interactions.
The natural background concentration of Gd and other rare earth elements (REE) occur at ultratrace levels [low ng/L]. Crust-normalized REE patterns show positive Gd-anomalies in surface water, groundwater, and recently also in tap water. The difference between the total concentration and its natural background concentration estimated by the REE pattern is the anthropogenic Gd.
Not only densely populated areas are affected by the presence of anthropogenic Gd. Studies have shown that even in rural areas without MRI facilities, anthropogenic Gd can be detected, since people are sent home after treatment. However, low input concentrations and mixing with natural waters lead to a decrease of Gd concentration below the current limit of quantification (LOQ) [1-5ng/L]. Often anthropogenic Gd cannot be calculated, although it is present, because natural background concentration cannot be determined with current methods, in particular in areas with low waste water load (e.g. headwater catchments).
A new method using an on-line preconcentration system “SeaFAST” (Elemental Scientific Inc., USA), in combination with a desolvation system “Apex Q” (Elemental Scientific Inc., USA) and a QQQ-ICP-MS instrument (Agilent Technologies, Japan) does lower the LOQ for REE by a factor of 10 to 20. The SeaFAST-system uses a resin with ethylenediaminetriacetic acid and iminodiacetic acid functional groups to preconcentrate specifically REE as they are exclusively trivalent while anions, alkali and alkaline earth cations are washed out. The Apex Q interface is also supposed to significantly lower oxide interferences.
We also evaluate a pretreatment in order to degrade the complexes and reach high recoveries of anthropogenic Gd. Our method will provide a determination of REE in ppq-levels, that significantly improves the differentiation between naturally and anthropogenic Gd. This will allow the detection of less than 1% waste water in SW and GW and finally increase the areas where studies of anthropogenic Gd could be conducted. A first application of our method was conducted during a field study in November 2014.