Usefulness of the Cl/Br ratio to identify the effect of reverse osmosis treated waters on groundwater systems

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The chloride-to-bromide molar ratio (R ? Cl/Br) is widely used in tracing groundwater salinity. Less experience exists on how some industrial processes such as the reverse osmosis (RO) water treatment modify the R value of desalinated water (P) and reject brine (T), and even less on how distinctive for hydrogeological applications the R changes are. This paper assesses the Cl/Br ratio usefulness to identify the effect of P and T on groundwater systems. First, the experimental R changes produced in P and T during standard RO operations and treatments of raw (I) seawater, brackish groundwater, and tertiary-treated domestic wastewater in nine RO plants (three in Gran Canaria Island and six in south-eastern continental Spain) were determined by means of the XP = RP/RI (R change in P) and XT = RT/RI (R change in T) ratios. XP and XT were respectively 0.90 and 1.07 for treatment 1 (weak pre-acidification) in one RO plant, 0.82 ± 0.09 and 0.94 ± 0.05 for treatment 2 (weak pre-acidification and weak pre-chlorination) in five RO plants, 0.63 and 0.97 for treatment 3 (moderate pre-acidification and strong pre-chlorination) in one RO plant, and 3.21 ± 2.02 and 1.00 ± 0.00 for treatment 4 (post-chlorination) in two RO plants. P was for irrigation (treatments 1 to 3) and for domestic use (treatment 4). Latter, the experimental XP and XT ratios were input data for six theoretical mixing scenarios aimed at showing how groundwater R changes in response to progressive contributions of P and T produced from different I water. The Cl/Br ratio enables to identify the effect of P from treatments 3 and 4, is scarcely effective for treatments 1 and 2, and is especially useful when P produced from seawater is used in other aquifer having different R. The Cl/Br ratio did not clearly identify T from any treatment.

Chloride-to-bromide ratio

Desalinated water

Groundwater mixing scenarios

Groundwater quality

Reject brine

Reverse osmosis

Acidification

Aquifers

Chlorination

Chlorine compounds

Groundwater

Groundwater resources

Mixing

Molar ratio

Reverse osmosis

Seawater effects

Wastewater treatment

Water filtration

Water quality

Brackish ground water

Chloride-to-bromide ratio

Desalinated water

Domestic wastewater

Groundwater mixing

Groundwater salinities

Groundwater system

Industrial processs

Industrial water treatment

aquifer

brine

bromide

chloride

desalination

experimental study

groundwater pollution

mixing

reverse osmosis

wastewater treatment

Canary Islands

Gran Canaria

Las Palmas

Spain