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Sources and behaviors of perchlorates ions (ClO4-) in chalk aquifer of Champagne-Ardenne, France: preliminary results

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Perchlorate (ClO_4^-) is an environmental contaminant of growing concern due to its potential human health effects and widespread occurrence in surface water and groundwater. It is considered to be potentially toxic even at low concentrations (> 4 μg.L^{-1}) especially for fetuses and infants because of its ability to disrupt the use of iodine by the thyroid gland and the production of metabolic hormones. Many studies have underlined perchlorate contamination in water from numerous countries including USA, Canada, France and China, with variables sources. . Analyzes carried out in France have highlighted presence of perchlorates (ClO_4^-) in drinking water of Champagne-Ardenne (a region located in the northeast of France). Two potential sources of perchlorate ions in groundwater are suspected in Champagne-Ardenne: a military source related to the First World War and an agricultural one related to past use of Chilean nitrates. Current knowledge about these sources and behavior of this molecule in this unconfined chalk aquifer is insufficient to manage this problem.

In order to determine the sources of perchlorates ions in groundwater, a study area of 600 km^2 has been selected in the east of Reims, where some drinking water catchments are concerned with perchlorate contamination. A first screening campaign has been realized in June 2017: water was sampled from 35 points including boreholes, springs and rivers (coming mainly form chalk aquifer drainage) in order to determine the contents of major and trace elements, ^{2}H and ^{18}O, ClO_3^- and ClO_4^- ions and 40 explosives.

Perchlorate ions were detected in almost all sampling points (32 of 35) with the max value of 33 μg.L^{-1} observed in groundwater. Average perchlorate level in boreholes is 6.2 μg.L^{-1}, higher than the average level in surface water (2.7 μg.L^{-1}). Most of the sampling points with perchlorate levels higher than 4 μg.L^{-1} are situated around the Monronvilliers military camp, where huge quantities of ammunitions have been used, stored and destroyed during and after the First World War. However, explosives have not been detected, which may be due to their low persistence in soil and water. These results provides a chemical mapping of the study area and helps to select 15 sampling points, where the same measurements will be done monthly over the next two years.

In parallel, the measurement of the isotopic signature of oxygen and chlorine in perchlorates ions makes it possible to precise the sources of perchlorates ions (agriculture or military). The monthly monitoring of ClO_4^- and the hydrodynamic behavior of this chalk aquifer allows to assess the spatial and temporal evolution of ClO_4^-concentrations in the coming years, with the aim of making appropriate recommendations for a long term management of this crucial groundwater resource.