

ISOTOPIC CHARACTERIZATION OF GROUNDWATER FOR DRINKING USE IN MULTILAYER AQUIFERS OF THE MILANO AND MONZA PROVINCES

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Management of groundwater resources for drinking purposes requires not only a classical chemical characterization for safety plans, but it implies the best possible knowledge of aquifer characteristics, recharge area extension and amount, seasonal and yearly changes in water table and discharge. A valid conceptual model of groundwater flow is a basic element for optimizing the groundwater withdrawals, both in terms of resource amount and of vulnerability to pollution.

In this framework, the use of isotope tools is based on several solid experiences in hydrogeology, but at the same time it is not frequently adopted by regional drinking water authorities. Besides of classical water stable isotope studies, analyses of nitrogen, carbon and sulphate isotopes are recently testified to be a fundamental tool for a dynamic management of water resources in areas affected by human activities.

Interaction between surface water and groundwater, origin and fate of contaminants, groundwater age evaluation, are some of significant improvements in groundwater conceptual model allowed by isotope field investigations.

For these reasons, the CAP Holding Company promoted in 2015-16 an extensive isotope characterization of groundwater used for drinking purposes in Milano and Monza Provinces (northern Italy). Three surveys have been conducted in November 2015, April 2016 and October 2016 by isotope analyses on more than 100 wells, tapping groundwater from different depths and related aquifer in the multilayer hydrogeological system of Padana Plain, between Ticino and Adda Rivers.

In addition to about 250 water stable isotopes ($\delta^{18}\text{O}$ and $\delta^2\text{H}$), more than 120 tritium analyses have been performed during the three surveys. Isotopes of nitrates ($\delta^{15}\text{N}$ and $\delta^{18}\text{O}$) and of sulphates ($\delta^{34}\text{S}$ and $\delta^{18}\text{O}$) are additionally investigated on more than 60 samples, as for $\delta^{13}\text{C}$ of DIC. An additional survey on $\delta^{14}\text{C}$ of DIC for 26 samples has been realized to compare groundwater age with tritium results. Finally, about 20 analyses have been conducted on chlorinated solvents for $\delta^{13}\text{C}$ and $\delta^{37}\text{Cl}$.

This study represents probably the largest isotope investigation on drinking groundwater in Italy and it is based on a conceptual model of groundwater flow developed by CAP Holding in the previous years. The available GIS with related database containing aquifer and aquitard limits, wells stratigraphy and filter location, and a large number of chemical analyses is constituting a solid background for refining and confirming by this isotope study the above



mentioned conceptual model.

Obtained results are useful to verify and implement the knowledge of the groundwater flow and resource regimen, indicating a significant stability of isotope values with time. Additional information have been acquired on nitrogen and chlorinated pollution origin and fate, and on local surface waters recharge, possibly due to irrigation channels and/or sewage systems. Relative groundwater age estimation is obtained and possible vertical exchanges in the multilayer aquifer system have been evaluated. Conclusions of the study will represent not only a valuable contribution for groundwater management, but they offer additional clues for further detailed characterization both at regional and local scale (up to single well management).

