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Isotopic approach to understand long-term trends of the behaviour of a multilayered deep aquifer system

O. Douez, M. Franceschi, T. Condom, A. Dupuy and O. Atteia

Institut EGID Bordeaux 3, University of Michel de Montaigne, Pessac, France

(douez@egid.u-bordeaux.fr)

The study of groundwater isotopic parameters gives information to understand long-term trends of the behaviour of aquifers. These data provide particularly significant elements to constrain the quantitative flow models. This approach was applied to define the conditions of recharge of the Infra-Molassic Sands (IMS) aquifer of the Aquitain Basin (Southwest of France) located in a regional multilayered aquifer system. This project is all the more significant as the IMS groundwater undergoes a strong anthropic pressure related to its use in various economic sectors such as the drinking water supply, the irrigation, the hydrotherapy and the storage of gas.

The apparent age of the water of IMS, resulting from the ^{14}C activity, ranges from –5,000 to –35,000 years BP. Most of the data vary from –15,000 and –29,000 years and present a gap around the Last Glacial Maximum (LGM, about –20,000 years).

No recent water age was found, and even near the outcrop areas. Groundwaters from the other aquifers of the multilayered system present similar ages, except on the outcrop zones.

The ^{18}O and ^{2}H contents of water of the IMS groundwater are lower than those of current precipitations. These results show that the climate was colder during the waters' infiltration than it is today. The estimated paleotemperatures, based on the noble gas concentrations, also allowed to show that the average temperature of the air during the infiltration was several degrees lower than the present one. These data are coherent with the evolution of the climate curve (Babick & Olive, 1997; Andre, 2002).

Thus, it seems that the last major phase of recharge of this aquifer took place during the Pleistocene and occurred during periods of climatic improvement before and after

the LGM, between –15,000 and –29,000 years, yet with a lack of infiltration during the LGM attested by a gap of ^{14}C data. This last phenomenon has also been observed on other large European aquifers, which can be explained by a drier period and/or by the presence of permafrost preventing the infiltration.

The increase in the precipitation and the melting of the discontinuous permafrost (present in Aquitaine during the LGM and enabling the storage of a large volume of water), after cold periods, might explain this major recharge of the IMS aquifer.

The study of these parameters highlights the fact that major climatic events are probably at the origin of the recharge of this large deep aquifer, and more generally speaking of this multilayered aquifer system. Currently, it seems that the IMS aquifer is only slightly recharged, so these waters should be considered as a reserve and not as renewable resource. This fact should be taken into account in the future quantitative flow models.