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From recharge to outflows: understanding deep aquifers groundwater circulations. The south Aquitaine Basin case study.

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The south of the Aquitaine basin (South-West France) is endowed with aquifers, but apart from alluvial unconfined ones, they are usually found beneath hundred meters thick cover of low-permeability formations. Among those deep aquifers lies the Infra-Molassic Sands aquifer aging from Eocene. This sandstone reservoir is of great interest because it has multiple uses, including drinking water, irrigation, geothermal applications and seasonal gas storage (André et al., 2002, C.R. Geoscience 334, 749-756). The uses depend on the location in the basin (120 km NS by 200 km EW) according especially to the access depth (up to 1500 m) and the depth to the piezometric level (from artesian to more than 100 m below ground level).

Since almost the beginning of the monitoring a downward trend is identified in the Piezometric level. Artesian behavior ceased consequently in some areas inducing the drying out of thermal springs. In order to mitigate the quantitative degradation of the resource, geological (Serrano, 1998), hydrogeochemical (Andre, 2002) and hydrogeological (Douez, 2007) studies were lead to better understand the main flow paths and potential interactions of these waters with sus- and subjacent deep horizons. However, due to the aquifer extensions (a bit less than 15 000 km^2) and the scarcity of the access points (less than 100 operated wells unequally distributed on the aquifer area), many questions remained unsolved.

From 2014, public and private institutions initiate new investigations on this Eocene aquifer, embracing numerous fields of the earth sciences. In geology and based upon more than 1000 wells and 5000 km of seismic profiles, an harmonized and detailed litho- and sequence stratigraphy was build up for the period ranging from Upper Cretaceous to Paleogene, allowing to recompose large scale sections, thickness and facies maps, and sedimentary response to compressive deformation (Lasseur et al, 2017; Ortega et al, 2017).

In the field of hydrogeochemistry, laboratory analyses of solid and liquid samples taken from springs or from different horizons into boreholes (Gal et al, 2016) help constraining the understanding of the groundwater flow paths. The cyclic fluctuations of sulfate concentrations in accordance to Piezometric variations were especially studied (Andre et al, 2016). Carbon and chloride isotopes analyses have been also used for groundwater age evaluation: the use of a new sampling method leads to identify older groundwater than previously estimated (Andre et al, publication 2018).

Regarding hydrogeology, investigations were focused on the understanding of recharge processes, as well as outflows possibilities. The former were studied through rivers gauging, permeability measurements and by analyzing the lithologies enabling groundwater infiltration and circulation. The latter followed three tracks: artificial discharge through uncapped artesian boreholes, groundwater discharge evolution with time where anticlinal structures make the aquifer outcropping and finally the possibilities of off-shore outflows.

All investigations are meant to be integrated in a hydrogeological multilayer groundwater model which may be used for the management of the Eocene aquifer.