Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.4526

Recharge origin and mixing processes in karstic thermal aquifers inferred from age dating dissolved gas and isotopic tracers

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Mean Residence Time and age distributions of groundwater are very efficient tools to understand the origin of recharge flow and characterize groundwater flow mixing in complex hydrosystems. The thermal karst aquifer of the Thau basin (South of France) illustrates the complexity of mixing processes that can occur in karst aquifers as three different end-members with contrasted residence time mix in this area : 1) shallow and young karstic water, 2) warm and mineralized thermal waters and 3) marine waters (Thau lagoon and/or seawater). In addition, for particular hydrological conditions, a flow inversion can occur downstream leading to a focused saltwater intrusion through the main outlet of the system, which modifies pre-existing mixing ratios. In this context, age dating can be used to discriminate and quantify the contribution of each groundwater end-member.

Within the framework of the “Dem’Eaux Thau project”, we used dissolved gases (CFCs, SF_6, He) associated with isotopic (^{3}H, 14C and ^{36}Cl) age dating tracers to quantify the different flow contributions within the karst system. Springs and wells representative of each end-member (surficial and deep karst, thermal system) were sampled for different hydrological conditions (high flow/base flow) and during a recent flow inversion (December 2020).

The first results show that most of the thermal groundwater has very low level of CFC/SF_6 and high He value indicating long Mean Residence Time and little mixing with recent water. In contrast, karstic springs show high dissolved gas contents indicating, for some of them, an anthropogenic contamination in their recharge area. This local contamination was used to highlight the influence of a local karstic recharge in some parts of the thermal system. ^{14}C and ^{36}Cl are used to described i) the influence of thermonuclear test in the shallow karstic end-member and ii) recharge evolution in the deep karstic end-member. The new sampling realized during the flow inversion allow quantifying the impact of the current marine contribution on the system.

These results will contribute to better quantify mixing ratio before and during the flow inversion. This work will in turn help to ensure a sustainable management of this water resource.