Of the importance of d-excess in understanding recharge process in two case studies of France

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OF THE IMPORTANCE OF D-EXCESS IN UNDERSTANDING RECHARGE PROCESS IN TWO CASE STUDIES OF FRANCE

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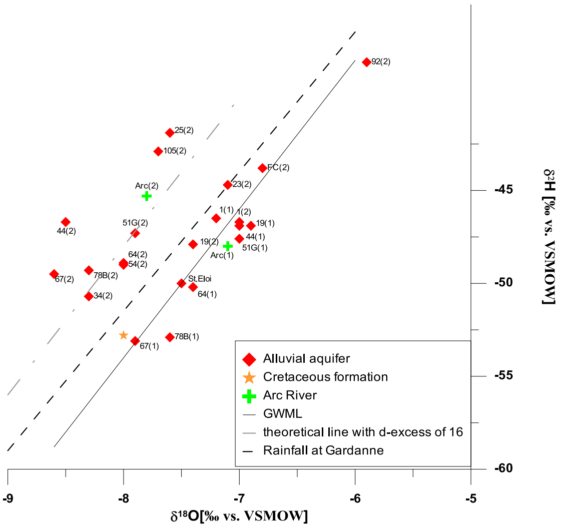
Stable isotopes of water (δ^2H and δ^{18}O) are classical tools for determining hydrogeological parameters ea. recharge area, flow directions, groundwater-surface water exchanges,… (Mook et al. 2008). However the successful use of the isotope techniques depends on local or regional hydrogeological characteristics. Meteorological and hydrological conditions leading to contrasting isotope composition of the water bodies are required.

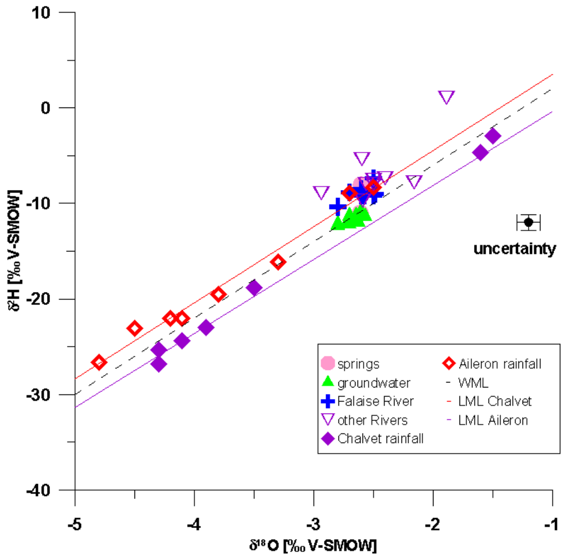
The relation between these two elements in precipitation from various part of the world is $\delta^2H = 8x\delta^{18}O + 10$. The so called Global Meteoric Water Line (GMWL) is characterised by a slope of 8 and an intercept with the ^{2}H axis of 10‰. This intercept is more generally called d-excess and may vary from 10 depending on the humidity and the temperature of the evaporation region. Then depending on the existing conditions during the formation of precipitation (=evaporation) and mostly at the site of sea-air interaction the d-excess may vary. The d-excess is then highly variable from one precipitation station of another and may reflect various so-called “effect” (continental, seasonal, altitude effects) as well as other processes such as re-evaporation of rain droplets…

In two recent studies carried out in south of France and in the Martinique French overseas the d-excess has proven to be a valuable tool giving additional and more evident information than the stand alone δ^2H and δ^{18}O.

In Berre plain, near Marseille, two sampling campaigns were carried out in October and in April. Samples from the deep calcareous aquifer, the alluvial aquifer, the Arc River and the water supply channel were analysed for δ^2H and δ^{18}O. The samples from October (1) plot quite well along the local precipitation line (Gardanne, Celle 2000) having a d-excess between 7,9 and 10‰. Part of the samples from the second sampling campaign (high stage water, 2 in the below figure) has a quite different d-excess, usually close to +16‰.
For the water having a similar d-excess in April and October, the aquifer is considered as less vulnerable as recharge process is quite slow. For the other points, as well as for the River Arc, the seasonal variation can be clearly seen showing high sensitivity to direct recharge processes (by surface water or precipitation).



Isotope composition of ground- and surface water collected in April and October in Berre plain (South of France)



δ^2H vs δ^{18}O at Falaise River Basin, Martinique

At Martinique (French West Indies), a study was performed during a short period of time (Dec. 2011 up to August 2012). The sampling site, at the North-Eastern part of the island, covered a great part of the basin area of the Falaise River. Altitudes of the river basin range from 30m (Chalvet groundwater sampling points) up to 1230m (Pele Mountain). A difference in d-excess was observed between high altitude precipitation (Aileron, 800m) and low altitude rainfall (Chalvet, 30m) (see figure). This was observed in the past for example by Gat and Dansgaard (1972) for the Jordan River System. This difference can be used to determine mean recharge altitude of groundwater and surface water basin in the studied site while δ^2H and δ^{18}O variation were more difficult to interpret.

References:

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