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# Water sources in a small Mediterranean watershed traced back with Sr isotopes, major and trace elements

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In the context of climate change, this study presents the ability of major/trace elements together with strontium isotopes to trace back water paths at small scale and to deconvolve the geochemical signal of a small watershed subject to intense flash floods episodes (Peyne, Hérault, France). Two small sub-basins draining distinct lithologies in their heads (Plio-Villafranchian conglomerate versus Triassic gypsum-rich marls and dolomites) and the same Miocene lithology downstream are investigated.
Major elements and Ca/Na vs. Mg/Na ratios classically applied at large scale to distinguish carbonate from silicate weathering, allow here discriminating the three main lithologies from the two sub-basins. Trace elements Rb and Sr coupled to calcium, also allow this lithological discrimination but in addition the Ca/Rb vs. Sr/Rb tracers appear to be much more discriminant for the various hydrological conditions. Thus, in combination with detailed lithological descriptions, they allow identifying the different facies that imprint the water signature through water-rock interaction according to the hydrological conditions.
Strontium isotopes and Rb/Sr ratio, discriminate more precisely the drained lithologies of the 2 sub-basins. Firstly, the 87Sr/86Sr ratios allow identifying the nature of the lithologies and their main component(s) contributing to the Sr budget in water and thus imprint the isotopic signature. Secondly, Sr isotopes evidenced two distinct Miocene facies: the detritric faction (sandy marls), and the marine carbonates.
The geochemical signatures of the brook samples draining both compartments were compared to the signature of the Peyne River outlet just before the confluence into the Hérault River. It appears that the signature of the Peyne River, integrating all the water draining the basin, is relatively stable whatever the hydrological conditions and mainly marked by the Miocene formations. Sr isotopes further highlight that this signature seems to result from the mixing of both Miocene facies present in the lower part of the Peyne watershed, i.e. the sandy marls and the carbonates. The typical signatures of the Plio-Villafanchian conglomerates and Triassic gypsiferous marls and dolomites of the headwaters of each sub-basin are completely hidden by the Miocene signatures. This should be related to the large drainage area of the Miocene compared to other lithologies, despite the high solubility of the gypsum formations releasing large quantities of dissolved elements in solution.
Understanding water paths at small scale is even more efficient when the geochemical approach is coupled with a detailed geological description. Indeed, the geochemical tracers are extremely dependent on the facies sequences (morphology) and of the soil nature (mineralogical composition), this is particularly sensitive at small scale.
In the context of climate change increasing the intensity of rain events in the Mediterranean region, and resulting in catastrophic floods events (flash floods), tracing the origin of water contributing to the runoff is of primary importance and this must be investigated at small scale. Geochemical and isotopic fingerprinting thus constitute excellent tools which can help to define the area of interest to be monitored in the framework of flood forecast and warning networks.