International Journal of Speleology	37 (1)	67-74	Bologna (Italy)	January 2008

Available online at www.ijs.speleo.it

International Journal of Speleology

Official Journal of Union Internationale de Spéléologie

Some applications of geochemical and isotopic techniques to hydrogeology of the caves after research in two sites (Nerja Cave-S Spain, and Fourbane system-French Jura)

Jacques Mudry[1], Bartolomé Andreo[2], Arnaud Charmoille[3], Cristina Liñán[2,4], Francisco Carrasco[2]

Abstract:

Mudry J., Andreo B., Charmoille A., Liñán C., Carrasco F. 2008. Some applications of geochemical and isotopic techniques to hydrogeology of the caves after research in two sites (Nerja Cave-S Spain, and Fourbane system-French Jura). International Journal of Speleology, 37 (1), 67-74. Bologna (Italy). ISSN 0392-6672.

Caves constitute privileged sampling spots to investigate the hydrochemical behaviour of infiltration, but the representative nature of samples can limit their reach. Taking this into account many results can be obtained from chemistry of water sampled in the caves. Carbonate tracers enable to reconstruct the 'history' of drip water water, including rainfall and temperatures. Moreover, permanent drip waters prove durability of water stored in the unsaturated zone over the cave, and lags between rain inputs and drip output enable to evaluate transit time through the unsaturated zone. The comparison of input/output concentrations can also contribute to estimate the local water balance of the site.

Finally, providing an access to the water table of the saturated zone, caves allow a calculation of mixing rates of infiltration water with water stored in the saturated zone.

Keywords: caves, hydrochemistry, isotope, residence time, water balance

Received 27 June 2007; Revised 12 December 2007; Accepted 4 January 2008.

INTRODUCTION

The karstic cavities have been traditionally studied from a scientific approach because they constitute the only natural way to enter into the karst aquifers, normally in the unsaturated zone. Previous investigations show the importance of unsaturated zone in the functioning of karstic aquifers. Thus, Williams (1983; 2008) and Perrin et al. (2003a) showed the role of the subcutaneous zone and the epikarst in the storage and maintenance of baseflow. Bottrel and Atkinson (1992) demonstrated by tracer test the relationship between residence time and the interconnectivity of the flow path. Tracing investigations done by Bottrell and Atkinson (1992), Smart and Friederich (1986) and Kogovsek (1997) have demonstrated that transit time between surface and caves can lag for hours in many cases. However this lag time could be months in other cases (Bakalowicz and Jusserand, 1987; Carrasco et al., 2006). Several authors deduced that hydrological functioning at drip water points inside caves depend on the overall volume of rainwater infiltrated in the aquifer (Baker et al., 1997; Liñán et al., 1999). Genty and Deflandre (1998) demonstrated that drip rate is influenced not only by rainfall but also by changes in the atmospheric pressure.

Understanding the functioning of the unsaturated zone of carbonate aquifers is highly interesting because it determines the passage of water towards the aquifer, and it is involved in karstification processes and in the types of water flow that may occur. Moreover, as water flows through this zone towards the inner part of the system, it is mineralised and the input signal is homogenised, i.e. the chemical and isotopic differences of the rain water are reduced. Yonge et al. (1985) showed that this homogenisation could occur in few meters of thickness.

Two types of infiltration can be distinguished in the unsaturated zone of carbonate aquifers (Bakalowicz, 1995; Perrin et al., 2003b): the first of these corresponds to the circulation of water through karst conduits, which ensures the rapid transit of water

1 Département de Géosciences, UFR Sciences et Techniques, Université de Franche-Comté, 16 route de Gray, 25030 Besançon, France. jacques.mudry@univ-fcomte.fr

2 Departamento de Geología, Facultad de Ciencias, Málaga, España. andreo@uma.es, fcarrasco@uma.es

3 NERIS - DRS – ESEG, Parc Technologique Alata, BP 2 F-60550 Verneuil-en-Halatte

4 Fundación Cueva de Nerja, Nerja (Málaga), España. cbaena@cuevanerja.com