CLIMATE CHANGE:THE KARST RECORD

Melbourne Autralia 29 september – 3 october 2014

Rainfall - cave dripping waters $\delta^{18}O$ relationships on long monitored stations Examples of Villars, Chauvet and Orgnac sites, south France

Dominique Genty[1], Inga Labuhn[1], Georg Hoffmann[1] , Philippe Jean-Baptiste[1], Elise Fouré[1], Pierre-Alain Danis[2], Olivier Mestre[3], François Bourges[4], Karine Wainer[5], Marc Massault[6], Edouard Régnier[1], Philippe Orengo[1], Sonia Falourd[1], Benedicte Minster[1]*

[1]Laboratoire des Sciences du Climat et de l'Environnement (LSCE/IPSL), Orme des Merisiers, 91191 Gif-sur-Yvette, France
[2]Pôle d'Etudes et Recherches Hydro-écologie des plans d'eau, IRSTEA, Unité Hydrobiologie HYAX, 3275 route Cézanne, CS 40061, 13182 Aix-en-Provence cedex 5, France
[3]Météo-France, Direction de la Climatologie, 42 av. Gaspard-Coriolis, 31057 Toulouse cedex, France
[4]Géologie-Environnement-Conseil, 30, rue de la République, 09200 Saint-Girons, France
[5]Dept. of Earth Sciences, Oxford University, South Parks Road, Oxford OX13AN, United Kingdom
[6]IDES, Université de Paris XI, bât. 504, 91400 Orsay cedex, France

*dominique.genty@lsce.ipsl.fr

The long (i.e. > 15 years for the longest) isotopic monitoring of cave dripping water revealed a very stable behaviour in most dripping stations of Villars, Chauvet and Orgnac caves, south France. We used local rainfall ($\delta^{18}O$ and quantity), monitored over same periods, as the input signal in the karst system over these caves. We found out that in order to explain the observed isotopic values of the cave waters and their stability over years, it is necessary to consider a mixing, in a reservoir, of the rainfall (weighted $\delta^{18}O$ of all months of the year or without August, the driest month) during several months to several years, even for shallow depths (i.e. 10-50m). The common idea that the cave dripping $\delta^{18}O$ can be assimilated to the mean annual weighted rainfall $\delta^{18}O$ is not true in all of our studied sites. Such a 12 month averaging still displays too large $\delta^{18}O$ variations (i.e. > 1-2 ‰) while the dripping stations $\delta^{18}O$ maximum changes are, in most cases, less than 0.2 ‰ over a > 10 years long period, with a standard deviation of 0.05 ‰. On the Villars cave (4 monitored dripping stations), in the 2 upper gallery stations, at about 10 m deep, the observed dripping $\delta^{18}O$ value is attained (with a recharge during all months of the years) after ~28 months, and a relative stability (i.e. 1σ ~0.3‰ regularly decreasing) after ~43 months. In the lower gallery, about 30m deep, the observed dripping value is reached much later, at about 140 months. If we consider that during the hottest month of the year, in August, no rainfall contributed to the recharge, then the upper gallery $\delta^{18}O$ value is never reached during the stable period, but stays too low by 0.2 – 0.3‰. For similar input conditions, the lower gallery $\delta^{18}O$ dripping stations (2) values of Villars cave are reached after ~32 months of rainfall integration. The reservoir feeding stalagmites is likely fed by slow and fast flow components and our isotopic modelling approach gives an apparent residence time of the dripping water which is surprisingly long. Tritium-Helium3 dating and tritium measurements made at the same places in Villars cave from 2009 to 2012, even if their interpretation is not straightforward, are consistent with the above results: Tritium-Helium3 ages are < 3years for both galleries. The ratio of tritium concentration between upper #10A and lower galleries indicates an apparent age difference between 200 and 300 days.
Another interesting results is the small, but significant $\delta^{18}O$ difference (0.2 ‰), observed between the dripping $\delta^{18}O$ of the upper (-6.17‰, two stations, 12 years average) and lower (-

6.38‰, two stations, 12 years average) galleries of the Villars cave. No certain explanation is given but lower $\delta^{18}O$ values in the lower galleries might be due to winter season overflows during infiltration and/or to older rain water with a different isotopic composition that reaches the lower galleries after years.
Despite its deeper position (50m/surface), the Chauvet cave stations isotopic composition is reached much earlier than in Villars cave and at 6 months of rainfall integration, dripping isotopic value of is reached. On the Orgnac cave, where 4 dripping stations are monitored since 2010, the deepest dripping station, about 100m deep, displays quite stable values (<0.15‰) whose mean value is reached after 53 month of rainfall averaging. Other less deep stations, at 55, 45 and 35m/surface, show more variability (<1‰). Finally, water monitored from a nearby well drilling, has a similar $\delta^{18}O$ composition to the other dripping stations and display close variability (i.e. <0.7‰).

Parallel to average residence times of the dripping water, this set of isotopic data also permits to draw conclusions on rainfall/local temperature relationships, position of dripping waters on LMWL and comparison with mesoscale climate model REMOiso whose numerical simulations well reproduce sub-annual $\delta^{18}O$ variations.