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# Thermic systems of Guadeloupe caves : consequences on sedimentation and wall preservation

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**Abstract.** Hygrometric and thermic measurements have been recorded to assess the microclimatology of some Guadeloupean caves. The results from Blanchard Cave and Morne Rita Cave, two Pre-columbian archeological sites, are presented here. Recordings have been conducted according to two modes: a short-step one which defines the daily cycle, and a long-term one which documents the annual cycle. Measurements show two distinct patterns. The first cave records temperatures globally warmer than the exterior conditions. But the regime is very unstable due to air currents bringing cold air deep into the cave. The result is a limited hygrometry and a very high sensitivity to daily hydro-thermic variations. Annual data collection reveals fluctuations in the hot air trap system, that we link to the influence of seasonal cloud covering. On the other hand, the second cave can be considered as a cold air trap. Lack of air currents helps to establish a more stable system, and a more humid air to be maintained in the cavity. Daily fluctuations are strongly weakened. However, seasonal variations are still recorded. These data open up prospects for further understanding of physical processes occurring in these sites. Thus, air flows that have been highlighted in the first site can explain the presence of evaporitic minerals in the ancient deposits by seaspray transported into the cave with cold air flows. Highlighting this supply also support the assumption that salt fretting contributes heavily to wall desegregation. A 0.6 cm/century weathering rate is thus estimated from sedimentation age model. Such a rate would explain the total lack of engravings in this kind of cave. Conversely, the stable system in Morne Rita cave would have favored the preservation of the Pre-columbian art.

## Sites :

Part of the common research program « Cavités naturelles de Guadeloupe, Aspects géologiques, fauniques et archéologiques », we assessed microclimatological patterns of several caves. We present here the best documented ones, both of them located on Marie Galante Island (French West Indies) (fig. 1). On the first hand, the Blanchard cave (fig. 2) is important because it delivered Pre-columbian archaeological artefacts and many Pleistocene paleontological remains. The Morne Rita cave (fig. 3), on the other hand, belongs to main petroglyph sites in the Lesser Antilles, and, in particular, is the only one having rock paintings preserved



Fig. 1 : Localisation of caves on Marie-Galante Island

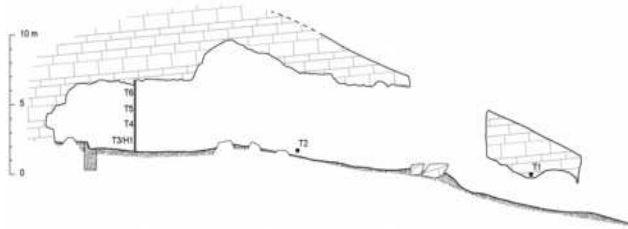


Fig. 2 : Profile of Blanchard Cave

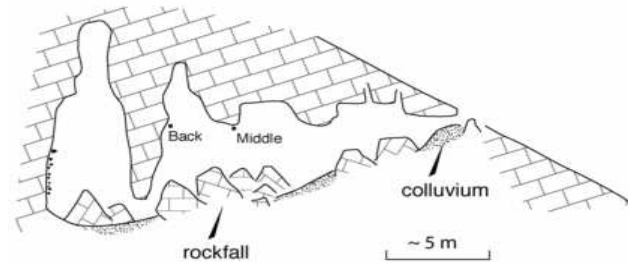


Fig. 3 : Profile of Morne Rita Cave

### Material and methods :

Both caves were equipped with temperature/humidity logger iButtons. Recordings were made with a 3 hours step for annual cycle recording and with a 1 minute step for daily cycle monitoring while we were on the ground. This recordings have been compared to MétéoFrance data coming from the meteo station of the airfield Les Basses, just a few kilometres from the sites.

### Results :

Recordings from november 2009 until September 2010 show a seasonal variability in both caves. However, two distincts patterns are clearly represented (fig. 4) :

- -The Blanchard cave works as a hot air trap, especially during rainy season.
- -The Morne Rita cave works all year long as a cold air trap.

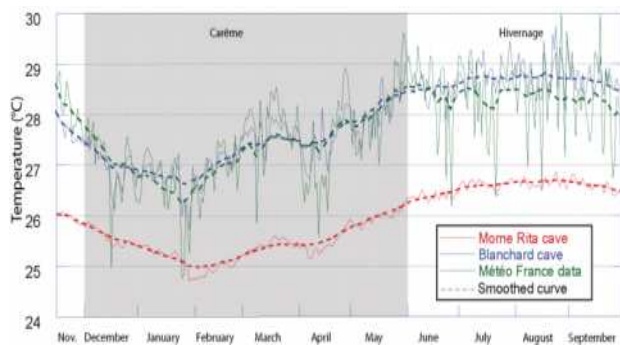


Fig. 4 : Mean daily temperature from the back of both caves and Météo France data between November 2009 and September 2010

Recordings with high resolution on short periods of time indicate also extremely different behaviours : the Blanchard cave is

very sensitive to external variations (fig. 5). It minimizes those variations but it suffers from them, as shown by the loss of temperature and air stratification during each rain event. Those air currents during day and/or night implies cold "dry" air entrance and hot "wet" air exit through the oculus, drying the whole atmosphere of the cave. Moreover, those air entrances bring sea spray in the cave. The Morne Rita cave recordings, to the contrary, show very weak variation during day (fig. 6). No or few air enter the cave, allowing it to remain very wet all year long.

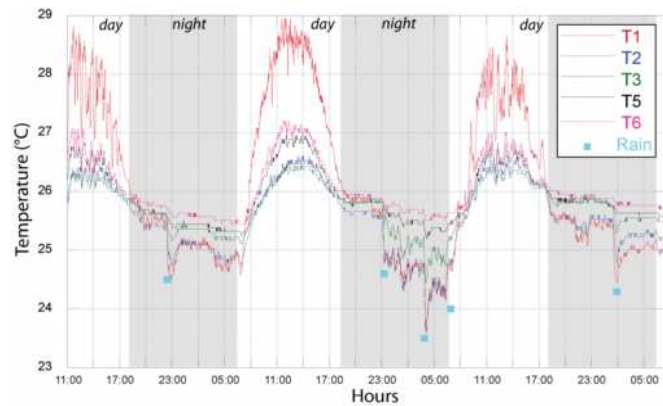


Fig. 5 : High-resolution temperature record in Blanchard cave correlated to observed rainfalls (Feb. 21-24, 2011)

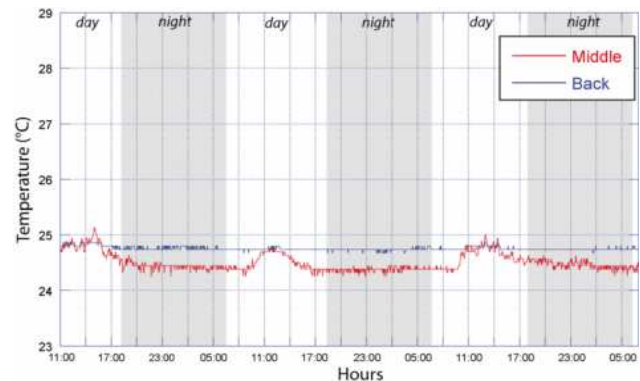


Fig. 6 : High-resolution temperature record in Morne Rita cave (Feb. 21-24, 2011)

### Discussion

Those two distincts patterns are crucial in the understanding of the caves. Indeed, instability in the Blanchard cave explain the dry ambiance of the cave. The cold "dry" air enters the cave, is warmed up once in the cave and then can dry the walls and the floor. This pattern explains the dryness of the soil and is cause of the incompleteness of the soil fauna. Consequently, the good preservation of the organic matter has permitted several meters of organic sediment to be accumulated in the cave. Instability in the Blanchard cave also lets seaspray enter the cavity, bringing salt on the walls and on the floor.

Those evaporitical minerals characterize the upper 30cm of the natural deposits that have been dated for the last 5.000 years. This expresses the littoral environnement of the cave from the mid part of the Holocene. This data allows a conservative estimate of a weathering rate by halocasty around 2mm/century. Such an high rate can explain the disappearance of the engravings that could have been produced during the Pre-columbian occupation of the cave 1000 years ago. Stability in the Morne Rita cave, on the contrary, allows the walls to be very well preserved by preventing any condensation-corrosion. In this cave, though, the salted water entrance through the fractures and the limestone itself explains the gypsum deposits on the walls and

in the engravings. Basically, wall exsudation brings to it surface salted water in which gypsum cristallise. This reaction occured on the whole surface of the cave walls, ceilings and blocks. More recently, during the Pre-columbian art activity, the gypsum crust on the rock were engraved. Fresh limestone was in contact with the air and a new layer of gypsum cristals grew in the engravings.

### Conclusion

Recordings in those two caves from Marie-Galante permitted to identify their microclimatological patterns. It brought us new elements to understand the two opposite wall preservation. Part of the sedimentation processes and preservation were also elucidated, and the littoral position of the Blanchard cave at the time Pre-columbian people were using it was assessed.