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

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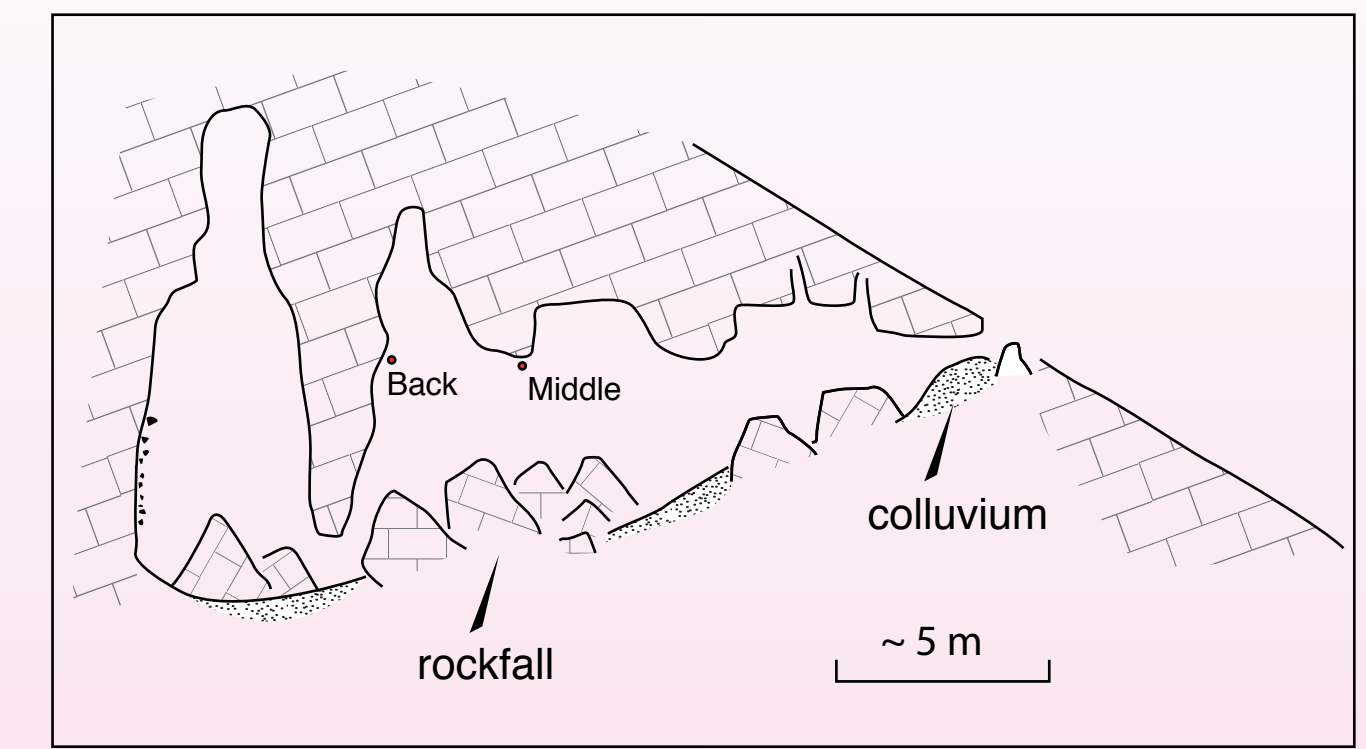
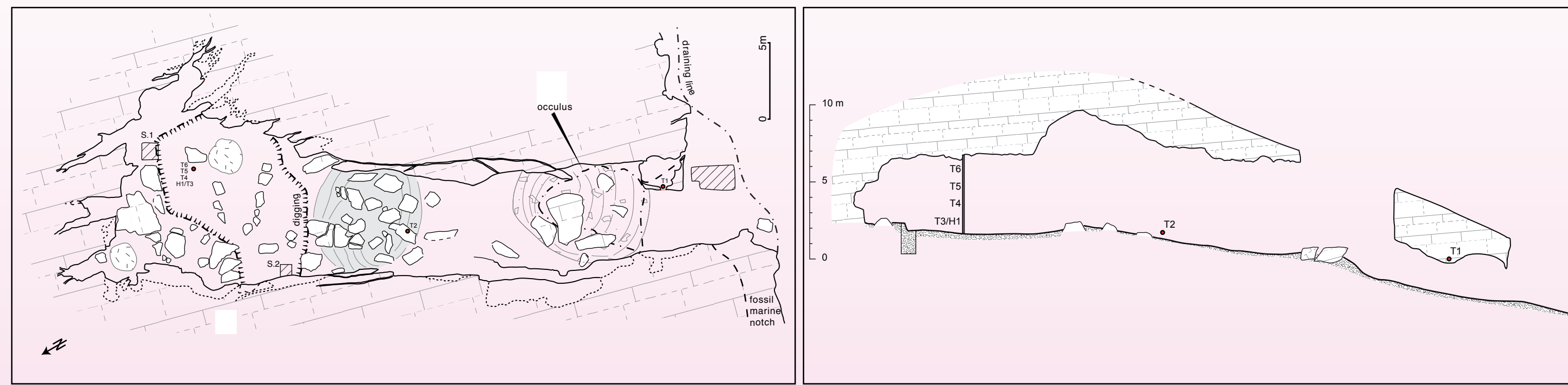
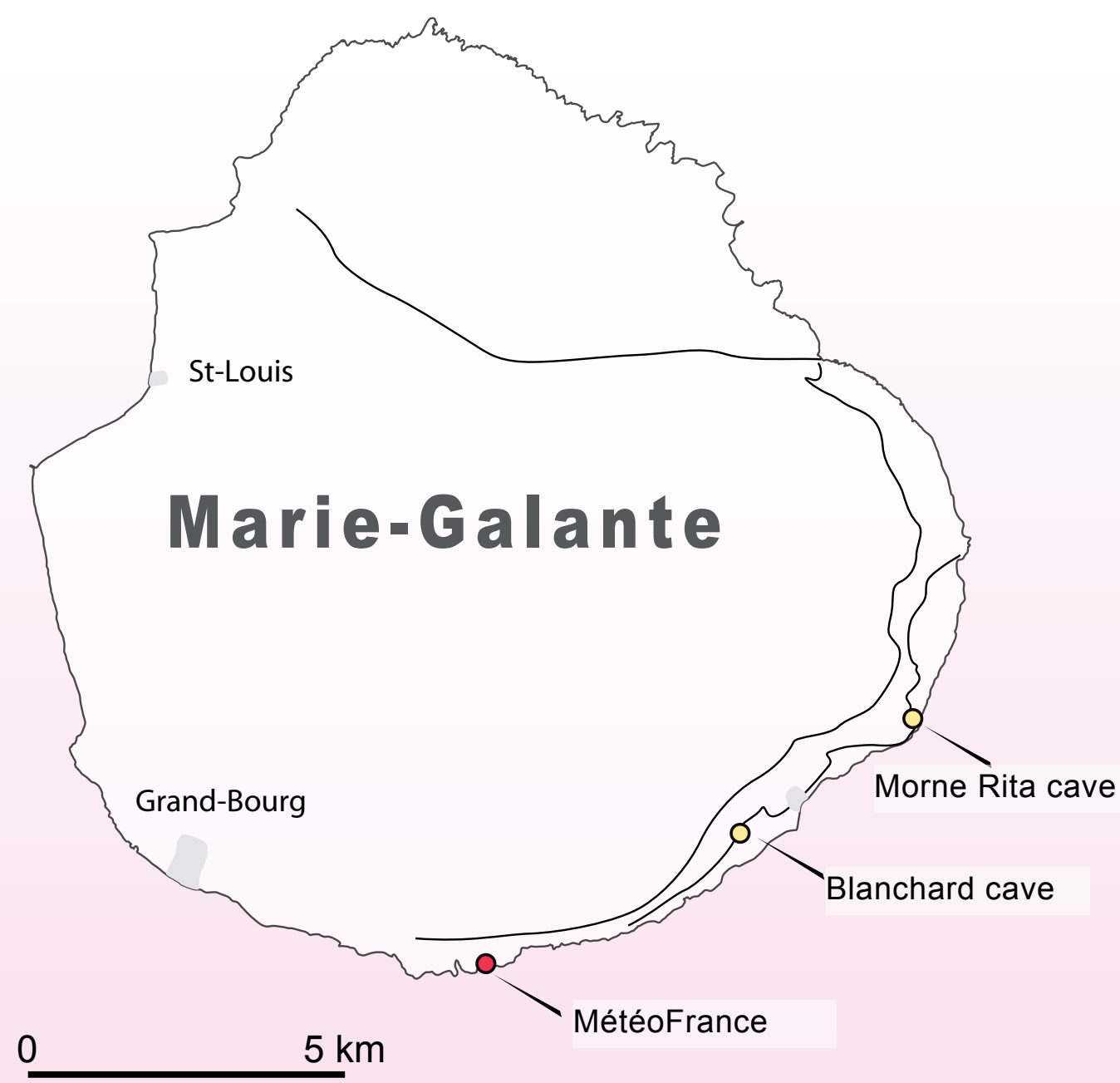
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Thermic systems of Guadeloupe caves : consequences on sedimentation and wall preservation

Material & methods



Sites :
 As part of the common research program « Cavités naturelles de Guadeloupe, Aspects géologiques, fauniques et archéologiques », we assessed the microclimatic patterns of several caves. We present here the best documented ones, both of which are located on Marie-Galante Island (French West Indies) (fig. 1). Blanchard cave (fig. 2) is important because it has revealed Pre-Columbian archaeological artifacts and numerous Pleistocene paleontological remains. Morne Rita cave (fig. 3) is one of the principal petroglyph sites in the Lesser Antilles, and, in particular, is the only one with preserved rock paintings.

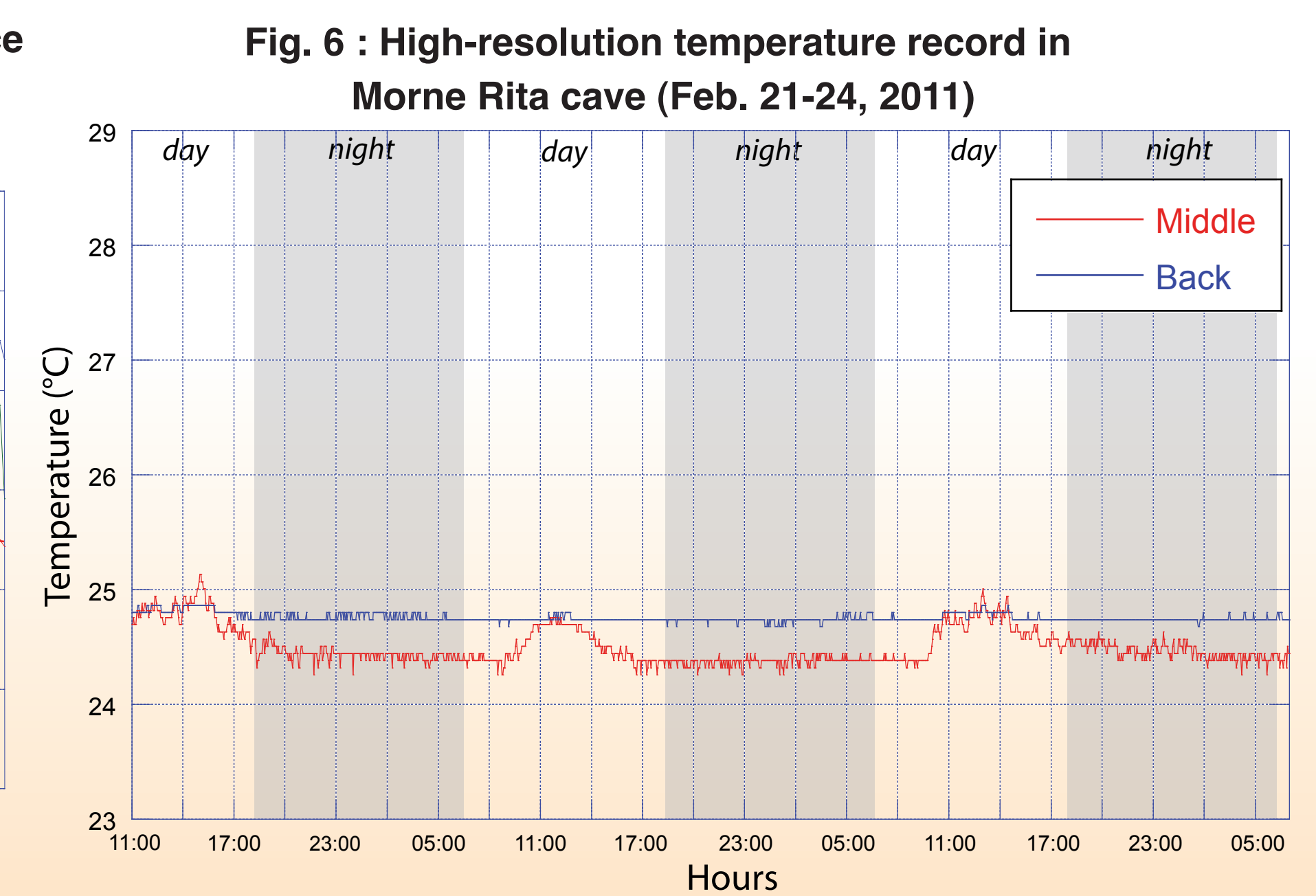
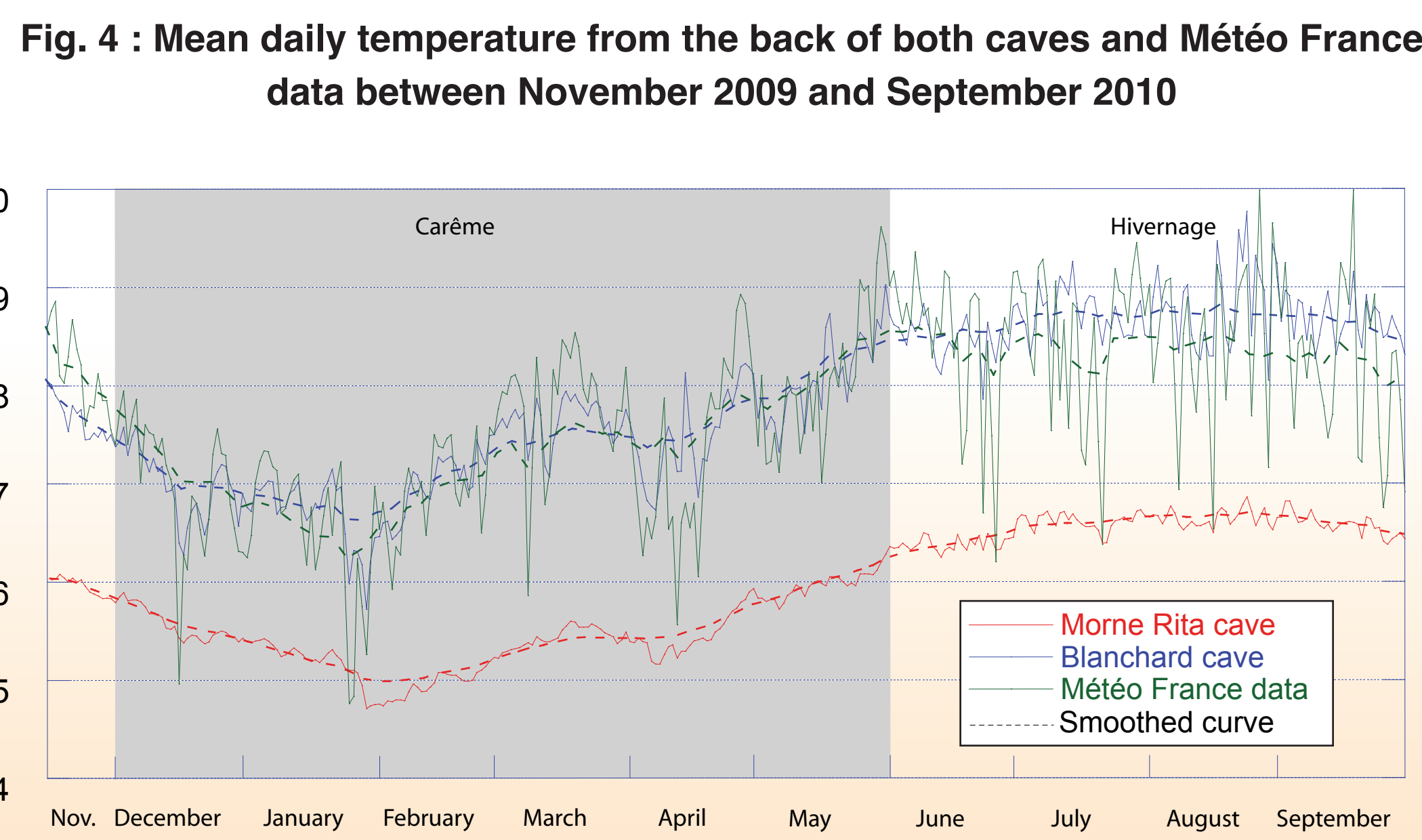
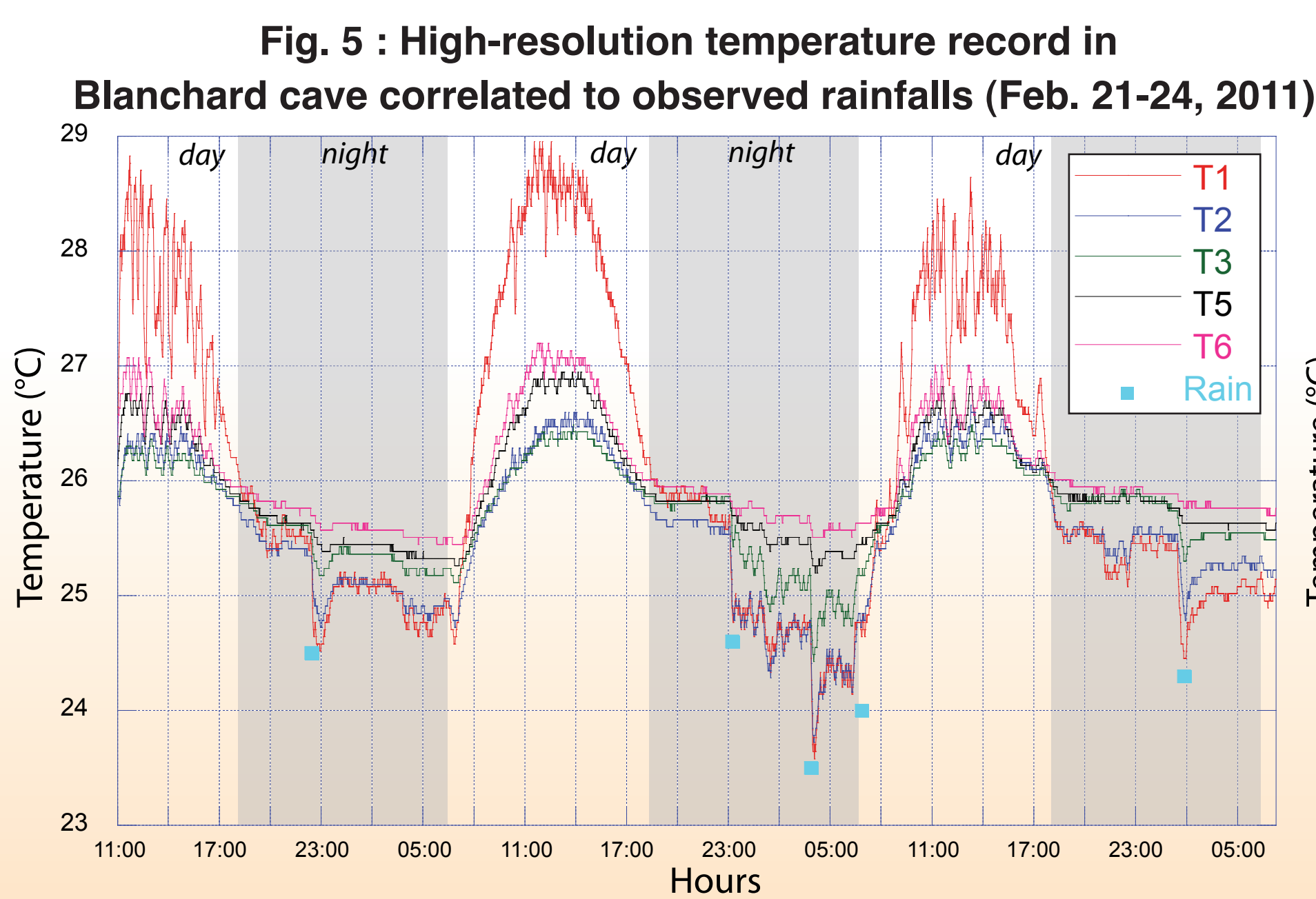
Fig. 2 : Map and profile of Blanchard cave

Fig. 3 : Profile of Morne Rita cave

Methods :

Both caves were outfitted with temperature/humidity logger *iButtons*. Recordings were made with a 3 hour step for annual cycle recording and with a 1 minute step for daily cycle monitoring while we were on-site. These recordings were compared to Météo France data collected from the Les Basses airfield station, located several kilometers from the sites.

Results



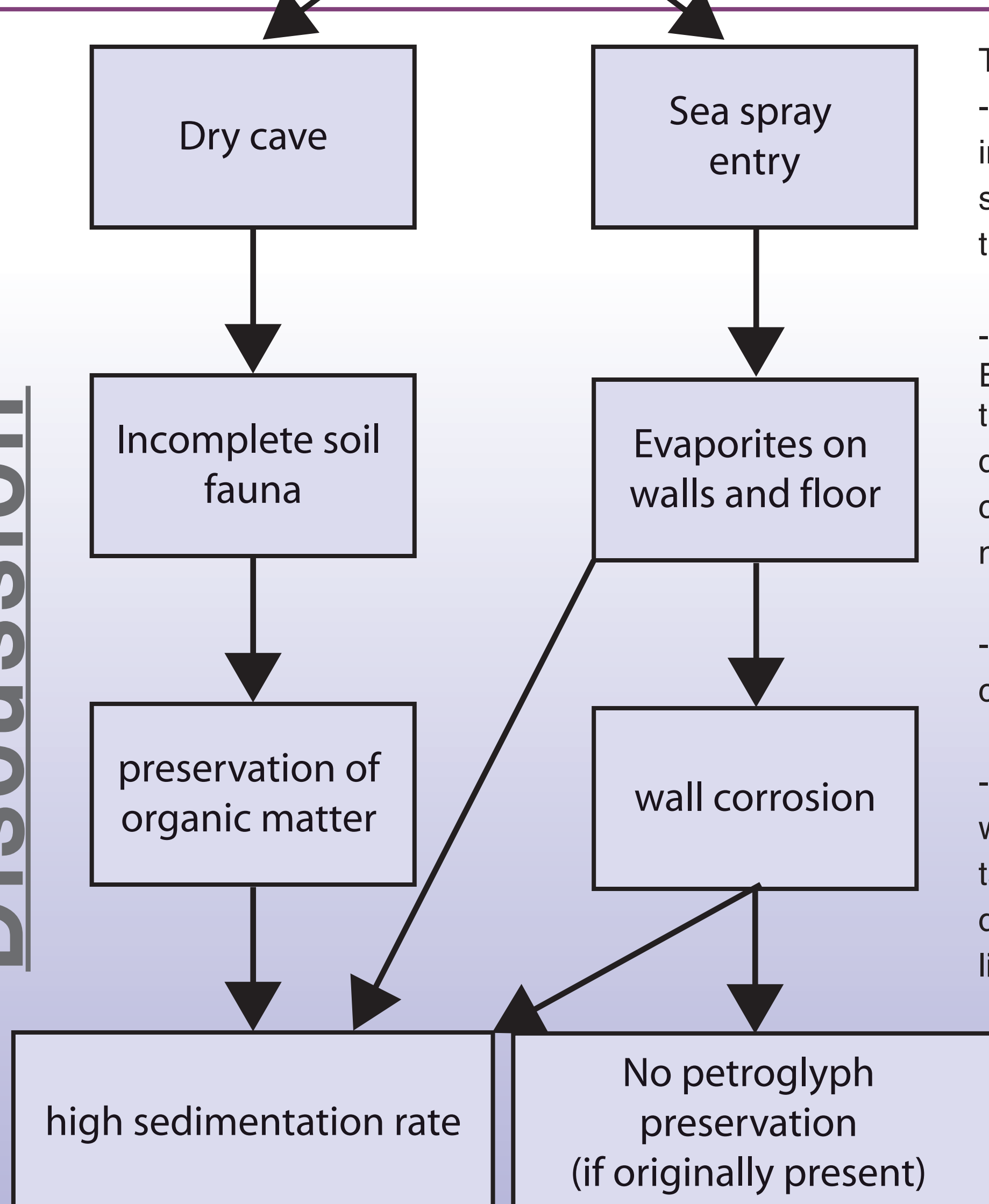
Recordings from November 2009 to September 2010 show seasonal variability in both caves. However, two distinct patterns are evident (fig. 4) :

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

Recordings with high-resolution over short periods of time also indicate extremely different internal dynamics :

- Blanchard cave is extremely sensitive to external variability. It is affected by this variability but to a minimal degree, as shown by the temperature decrease and an absence of air stratification during each rain event.
- Daytime or nighttime air currents imply that cold air entered the cave and hot air exit through the oculus.
- The data from Morne Rita cave recordings, to the contrary, show little daily variability (fig. 6). Little or no air enters the cave, thus allowing it to remain extremely humid all year round.

Discussion



These two distinct patterns are crucial for understanding the caves :

- Instability in Blanchard cave explains its dry conditions. The cold "dry" air enters the cave, is warmed once in the cave, thereby drying the walls and floor absorbing humidity. This pattern explains the dryness of the soil and is the reason behind the lack of certain classes of soil fauna. Consequently, conditions that allow for the preservation of organic matter have resulted in accumulation of several meters of organic-rich sediment.

- Instability in Blanchard cave allows sea spray to enter the cavity, bringing salt onto the walls and the floor. Evaporitic minerals characterize the upper 30cm of the natural deposits, which have been deposited within the last 5,000 years. This characterizes the littoral environment of the cave from the mid-Holocene. These data allow for a conservative estimate to be made of the haloclastic weathering rate, which ison the order of ca. 2mm/century. Such a high rate would explain the disappearance of any Pre-Columbina engravings that might have been produced during human occupation of the cave 1000 years ago.

- Stability in Morne Rita cave, on the contrary, allows the walls to be very well-preserved by preventing any condensation-corrosion.

- The entrance of salt water through fractures and the limestone itself explains the gypsum deposits on the walls and in the engravings. Basically, wall exudation brings salt water to the surface on which gypsum crystallizes. This reaction occurred over the entire surface of the cave walls, ceilings and blocks. More recently, during the Pre-Columbian art activity, the gypsum crust on the rock was engraved. This newly exposed limestone was in contact with the air, and a new layer of gypsum crystals formed in the engravings.

Conclusions :

the records from these two caves allow for the identification of detailed internal microclimatic patterns. These data have allowed us to understand the processes behind their opposed states of wall preservation. Aspects of the sedimentation processes and their preservation were also elucidated.