Typology of karst systems

One of the most original features of the Famenne – Ardenne Geopark is, incontestably, its karst. This term refers to a series of natural forms: massive river losses (swallow holes), closed depressions, massive spring resurgence, caves and potholes, and subterranean rivers, all of which develop primarily in calcareous rocks. Together, they form an ensemble known as a karst system. This in turn may be defined as the area of underground drainage that leads to an emergence, encompassing the initial loss of the river or stream, the infiltration surfaces and the resurgence of the water from underground.

Geology and an Appalachian-style relief determine two major types of karst system: underground meander cut-offs and chantoir/swallow-hole-resurgence systems. These are based on the two main kinds of rivers that flow through the Geopark. The first are the epigenetic rivers, incised deep into the bedrock, flowing across all type of rock formations without distinction: the Ourthe, Lesse, Lomme, Ry d'Ave, a.s.o. Elsewhere, streams or small rivers flow across the plateau and form tributaries to the epigenetic rivers. The former are affected by underground meander cut-offs, the latter by chantoir-resurgence systems (figure 1).

Underground meander cut-offs

A classic example is provided by the karst system of the subterranean stretch of the river Lesse at Han-sur-Lesse, the heart of the Geopark. After flowing down from the sandstone/shale heights of the Ardenne, the Lesse flows on the surface across a first strip of Givetian limestones between Resteigne after Belvaux. After passing the Belvaux shale depression, the river encounters Boine hill, and turns first to the east in order to skirt it. Then, taking an oblique line to the north, it plunges underground into the Gouffre de Belvaux to re-emerge at the Trou de Han. The surface valley continues across the limestone hill, reaching the Han shale depression to the north before returning in a huge meander towards the Trou de Han: this is "la Chavée". This example illustrates the main characteristics of this type of karst system. The slope is shallow: in Han, only a matter of metres between loss and resurgence. Flow rates, on the other hand, are often considerable, of the order of several cubic metres per second in Han, and occasionally exceeding 100 m^3/sec. A network of this type will not, therefore, contain pits but rather vast galleries and collapsed chambers. The existence of a dry valley circumventing the massif in meanders is also a classic criterion. This valley may be dry for only part of the year, as in the case of la Chavée, or permanently occupied by the river, as in the case of Rochefort. It is important to note, however, that in the latter instance, the containment of the Lomme thalweg prevents the river from running dry for part of the year.

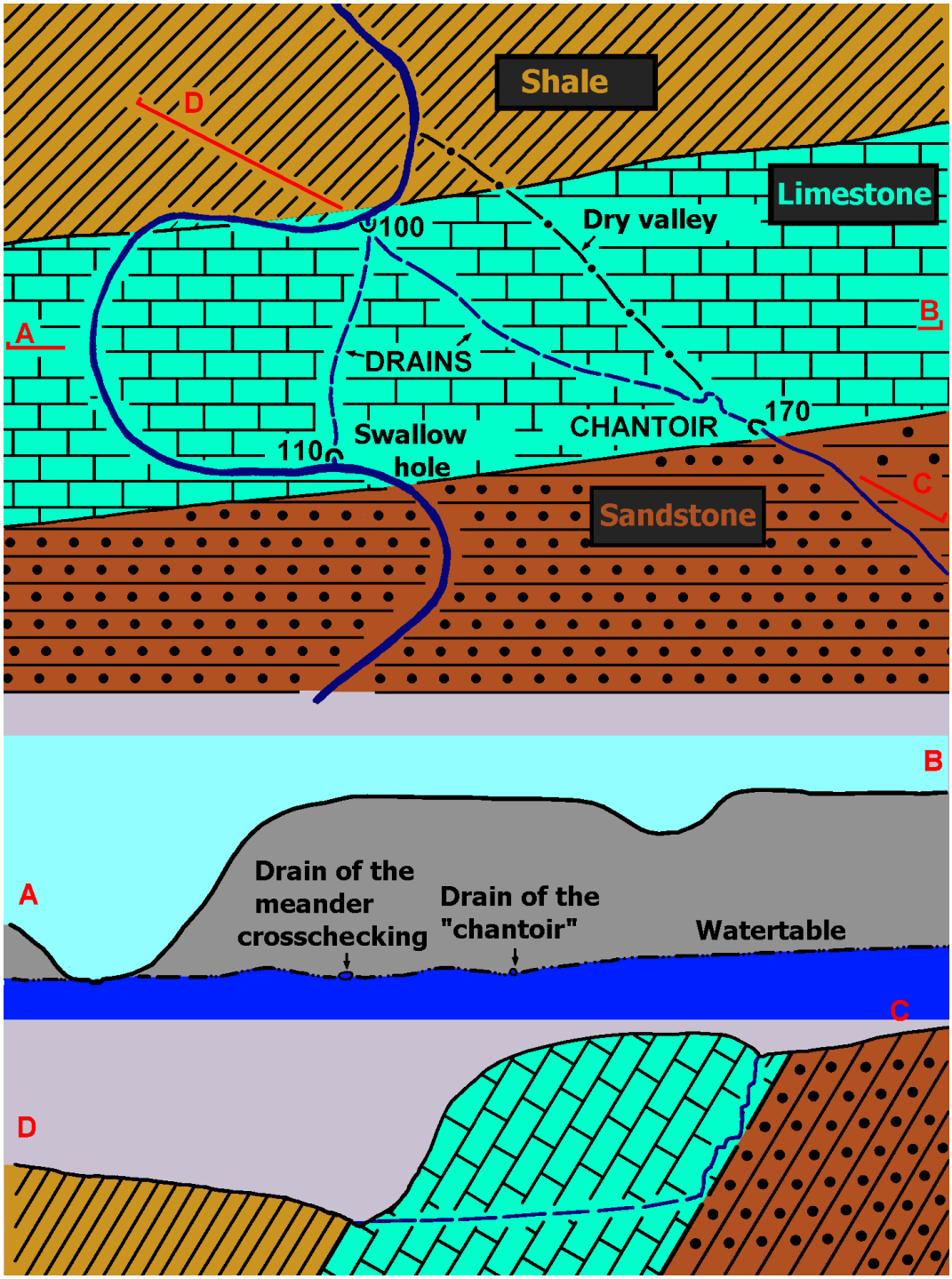

Figure 1. The different types of karst systems. *This principle figure shows a major epigenetic river (thick blue line), incised deep into the primary bedrock. When it leaves behind the sandstone and enters the limestone sector, the river is partially lost in an "adugeoir" (swallow-hole) and re-emerges on the other side of the meander: this is a subterranean meander cut-off system. The difference in altitude between the point of loss and the resurgence is small. A stream flowing down from the sandstone massif disappears into a chantoir (plateau loss) and re-emerges in the bottom of the main valley. This is a chantoir-resurgence type network. The altitude differential between the chantoir and the resurgence is much greater (70 m in the Han-Rochefort region), creating a mainly vertical cavity that generally channels the waters swiftly to an altitude close to the piezometric surface.*

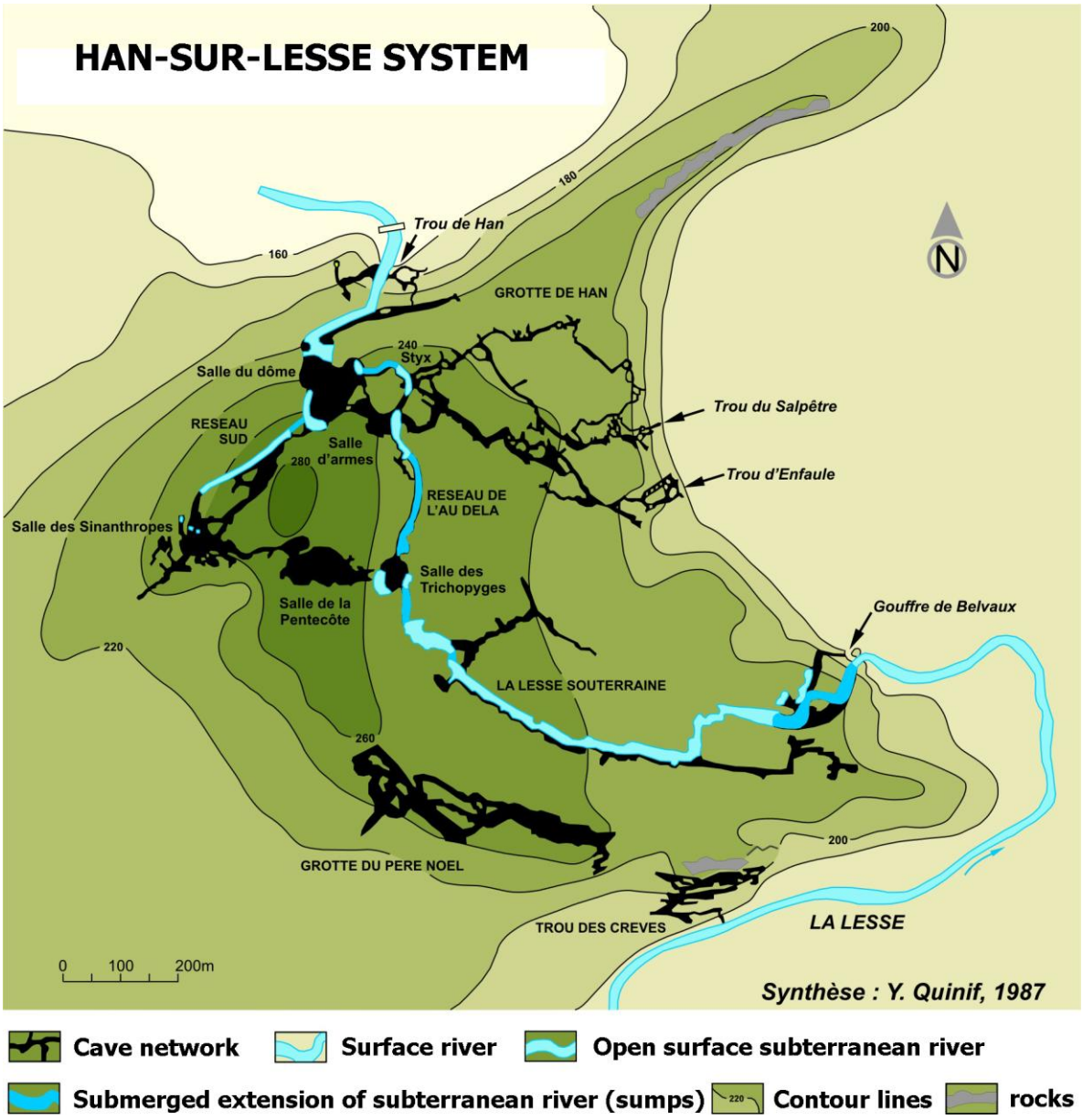

***Figure 2. Map of the Lesse subterranean karst system at Han-sur-Lesse**. This system is noteworthy in that the river has been explored by cavers and divers along almost its entire length. Numerous other galleries and cavities add to the complexity of what is the largest system of its kind in Belgium.*

Chantoir-resurgence systems

Now let us turn our attention to another major karst system in the Geopark: the Hotton system, at the heart of which lie the Caves of Hotton. The map is explicit (figure 3). On the plateau that rises to the west over the Ourthe, an epigenetic river analogous to the Lesse, streams flow down from the south, from heights formed from hard, impermeable rocks. As the flow northward, they encounter the limestone strip of the Calestienne, running from west to east. At this point, they disappear vertically into **chantoirs** or plateau swallow-holes.

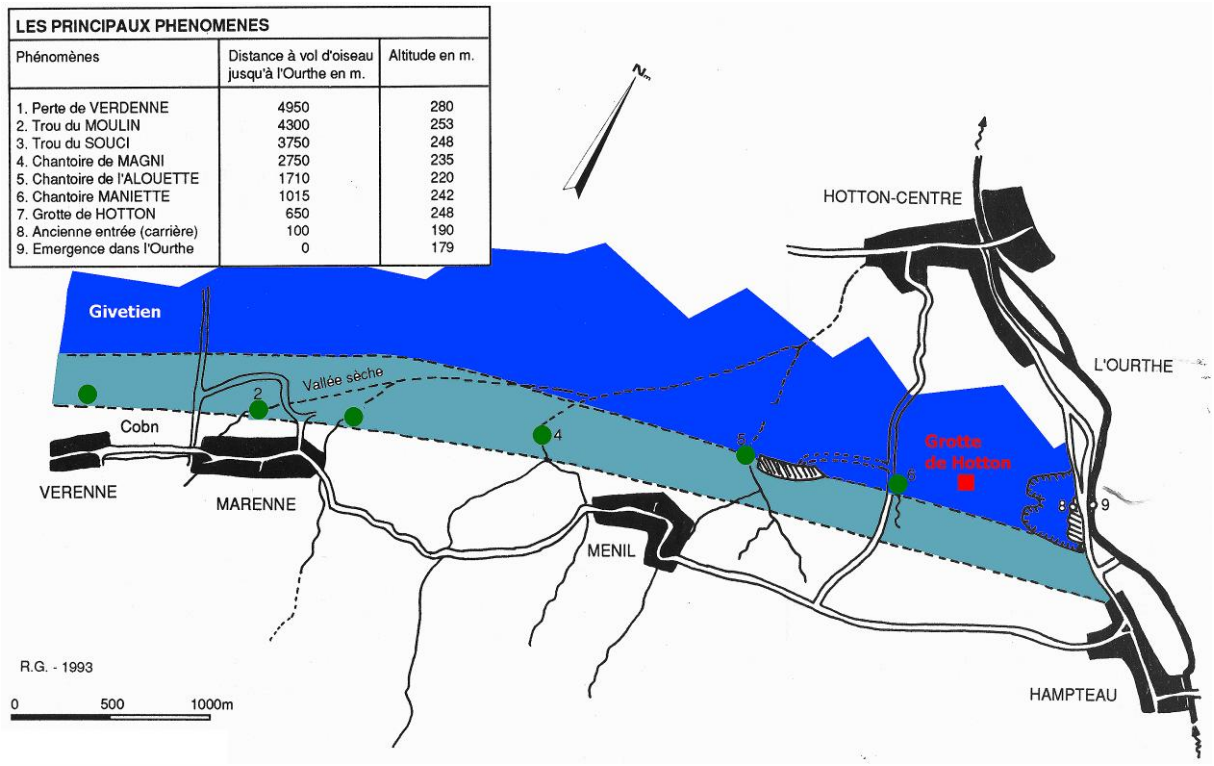

***Figure 3. Schematic map of the Caves of Hotton karst system**. This system may be considered a classic example of the chantoir-resurgence system. Streams that disappear into the limestone merge underground into a subterranean river that flows through the Caves of Hotton.*

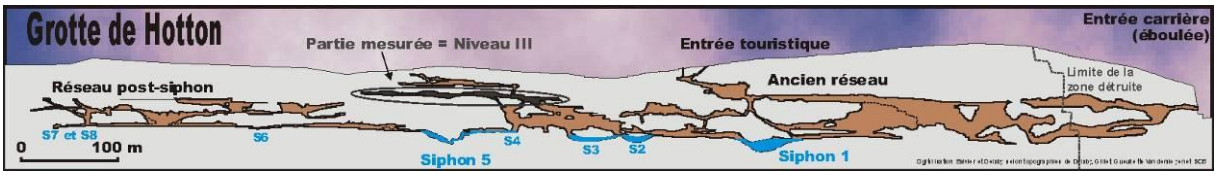

***Figure 4. Cross-section of the Caves of Hotton**. This cave system presents a superimposition of levels of galleries at different altitudes.*

The Laide Fosse chantoir is an ideally representative example of a chantoir or swallow-hole. A temporary stream flows from the top of Hamerenne hill over sandstone. Once it reaches the argillaceous limestones of the Hanonet Formation that marks the end of the Eifelian Stage, just before reaching the pure limestones of the Givetian, the stream plunges into a deep ravine that comes to a dead-end not far from the road between Han-sur-Lesse and Hamerenne (figure 5). A narrow vent marks the disappearance of the stream. The radar plot clearly highlights this fluviatile relief (figure 6). The cavity that follows on from the loss is a chantoir, through which the water flows swiftly into the depths (figure 7).

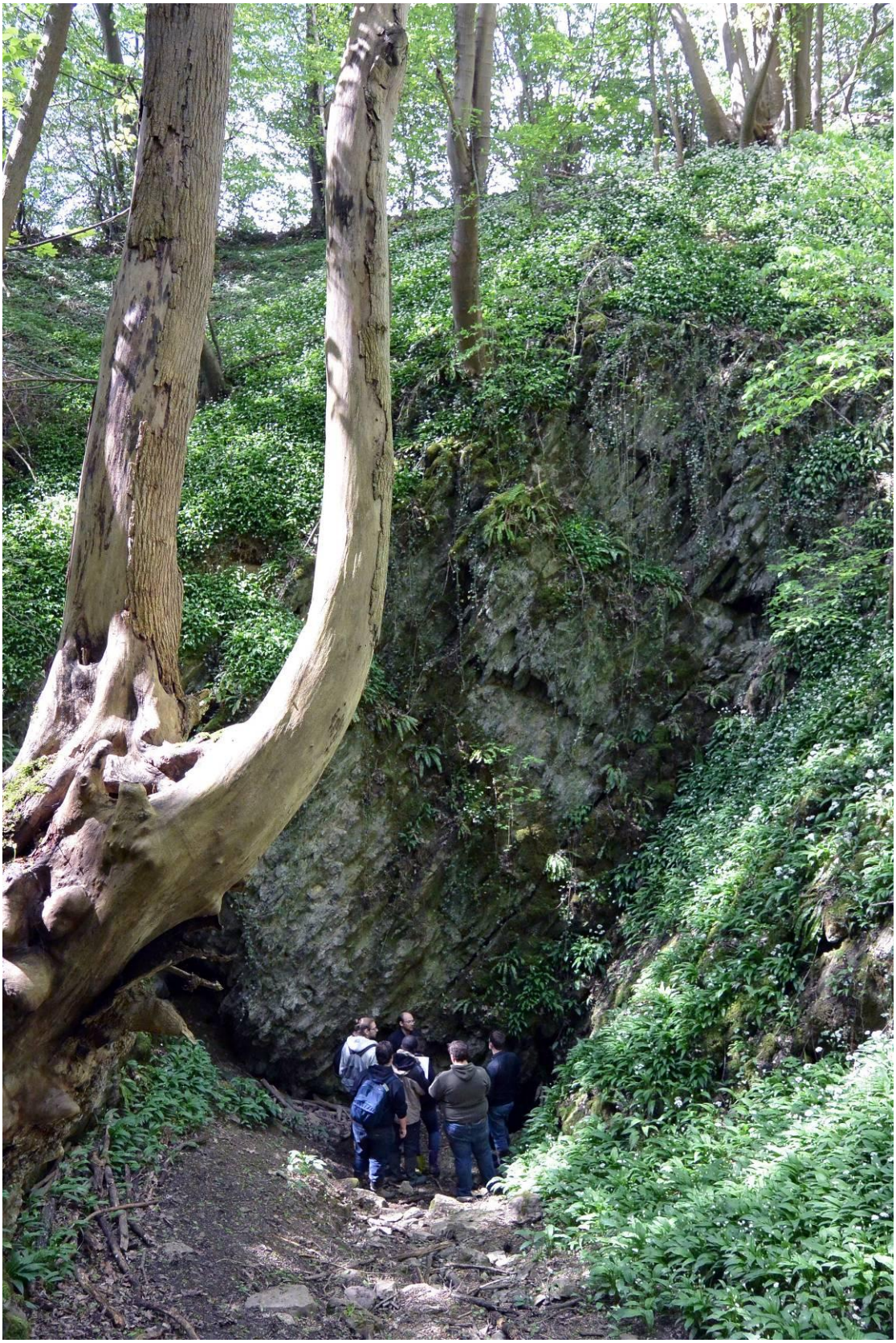

Figure 5. Entrance to la Laide Fosse. *The photo is taken from the thalweg along which the stream, currently dry, normally flows. The entrance to the cavity lies just below where the walkers are standing.*

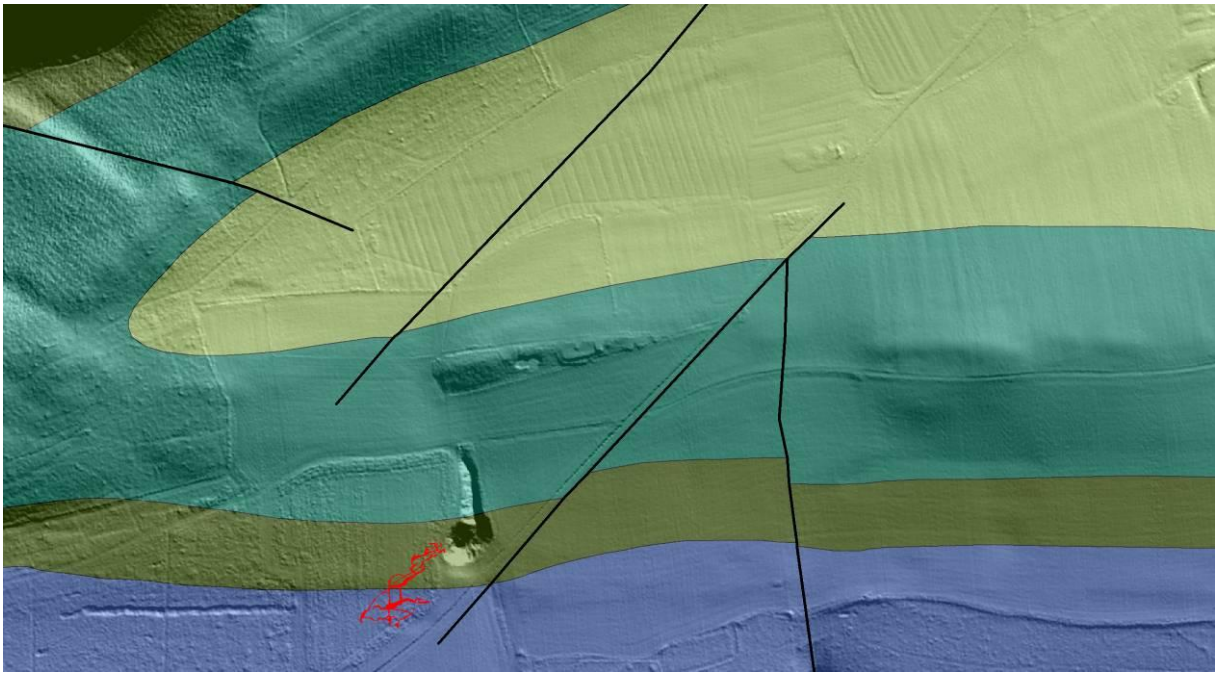

***Figure 6. La Laide Fosse chantoir**. This figure is a combination of the geological map and a radar plot. The layout of the cave is marked in red. The ravine leading to the cave is clearly visible. It begins in the Lower Devonian shales and sandstones (Lomme Formation) which, with the Jemelle Formation (shades of green) makes up the heights of Hamerenne hill. Once the stream reaches the argillaceous limestones of the Hanonet Formation (dark green), it disappears underground at the bottom of the blind valley. Figure created by Amaël Poulain.*

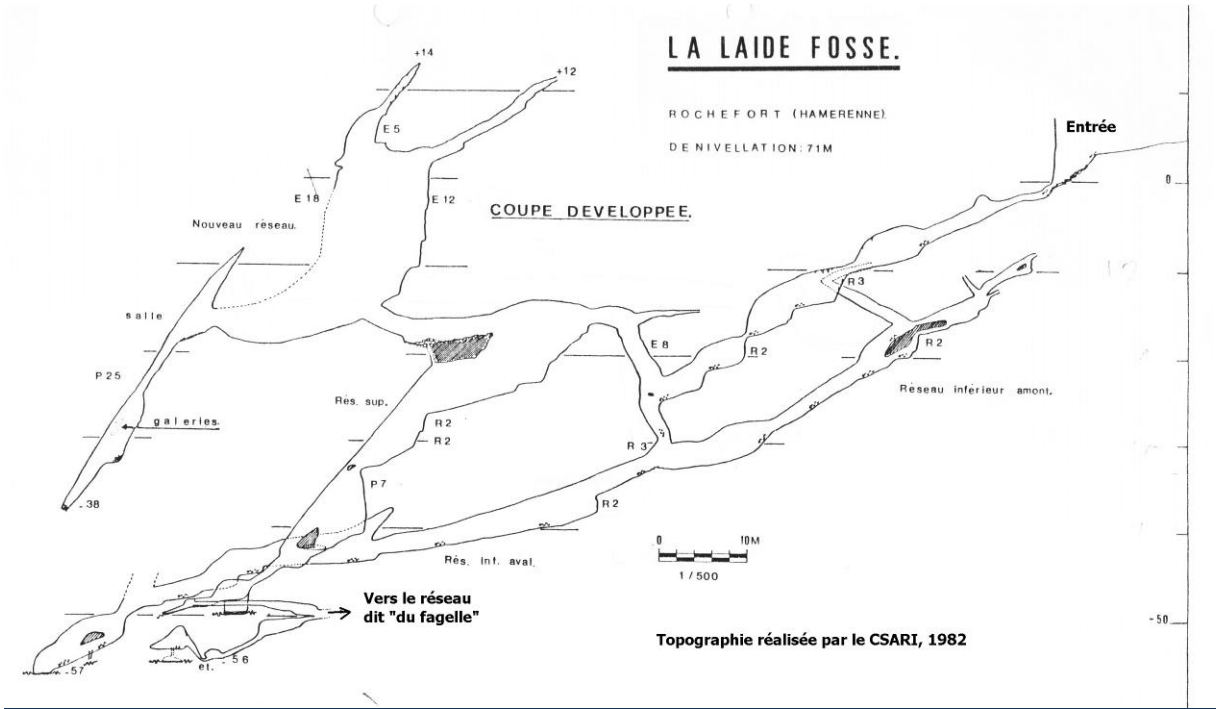

Figure 7. Cross-section of la Laide Fosse.