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THE GRAND COYER KARST, EXPLORATION AT THE COULOMP SPRING (ALPES-DE-HAUTE-PROVENCE, FRANCE)

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The Coulomp Spring (elevation 1306 m) is the largest of the Var River watershed (Q ≈ 1 m^3/s). The catchment of the Coulomp Spring is about 30 km^2. It culminates at the Grand Coyer (elevation 2693 m), which is located east to Annot City, between the Var and Verdon rivers. Almost no cave is known in the catchment, excepting the Lignin lake sinkholes. The grotte des Chamois is an ancient outflow of the Coulomp Spring. The pumping of sumps allows us to enter into the cave system, which is made of several levels of large galleries (20 x 30 m at the maximum), with a strong air flow. Currently the cave is 3 km long.

Résumé

LE KARST DU GRAND COYER, EXPLORATIONS À LA SOURCE DU COULOMP (ALPES-DE-HAUTE-PROVENCE, FRANCE). La source du Coulomp (alt. 1306 m) est la plus importante du bassin du Var (Q ≈ 1m^3/s). Elle draine un bassin d'environ 30 km^2, culminant au Grand Coyer (alt. 2693 m), situé dans le secteur d'Annot, entre Var et Verdon. Hormis les pertes des lacs de Lignin, qui alimentent probablement la source, la surface est pratiquement exempte de cavité. Le pompage de siphons dans la grotte des Chamois, ancien exutoire de la source du Coulomp, a donné accès au réseau organisé en plusieurs étages de galeries de grandes dimensions (max. 20 x 30 m), avec un fort courant d'air. Le développement est actuellement de 3 km.

1. Location and Access

Castellet-lès-Sausses, Alpes-de-Haute-Provence, France

Chamois Cave (Lambert II, after Créac'h 1987): X = 949.35 – Y = 203.87 – Z = 1370

Coulomp Spring: X = 949.85 – Y = 203.995 – Z = 1306

The Grand Coyer (2693 m) massif locates in the French Southern Alps, about 100 km northward to the French Riviera and to Nice, between the Verdon River to the North and the Var River to the South (Fig. 1). The Coulomp River is a Var tributary. Its spring locates at 1306 m elevation, in a middle of a wild area, with no roads and no inhabitants. Only the Aurent hamlet is occupied in summer for vacations. Wild fauna is often encountered, such as foxes, chamois, ibex, bighorn sheep, eagles, vultures, and sometimes wolves. A 40 minute walk leads to the Aurent hamlet, which has no road access (Fig. 2). Then 1.5 hour more walk is required to reach the spring, either following the river in summertime, or by a dizzy track along steep badlands. A 60 m high scenic waterfall indicates the position of the spring (Fig. 3). The cave opens 64 m above the spring, 15 m above the foot of the cliff, as a 4 m wide portal.

2. Previous Explorations at the Chamois Cave

- First mentioned by Martel [1921 p. 576, 586; 1928 p. 73], who visited the cave in October 1908 and June 1909 (Fig. 3) [comm. D. André].
- Bertrand [1914], in June and September 1913, carried out a study of the spring and its catchment for the water supply of Nice city. Capturing the spring has begun, but was definitely stopped because of the declaration of the First World War.
- **1971-74**: The Caving-Club of Nice (R. Bergamo) makes a survey up to the first sump. They open the

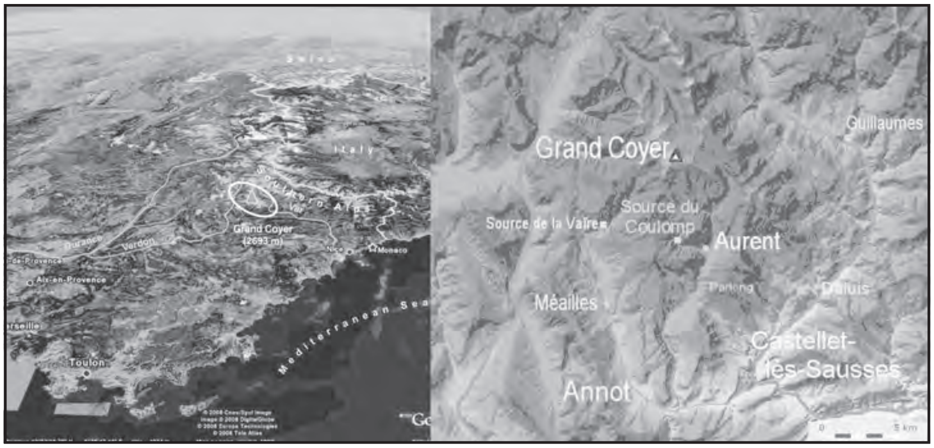

Figure 1: The Grand Coyer (2693 m) massif locates in the French Southern Alps, about 100 km north to Nice. The catchment area of the Coulomp spring extends up to the Grand Coyer. The Chamois Cave locates just above the spring. 3h walk in the mountain is required from the last road to reach the cave.

Figure 2: View toward Aurent hamlet and Beaussebérard. Following the Coulomp in high water (4 m3/s). The dizzy track to the spring.

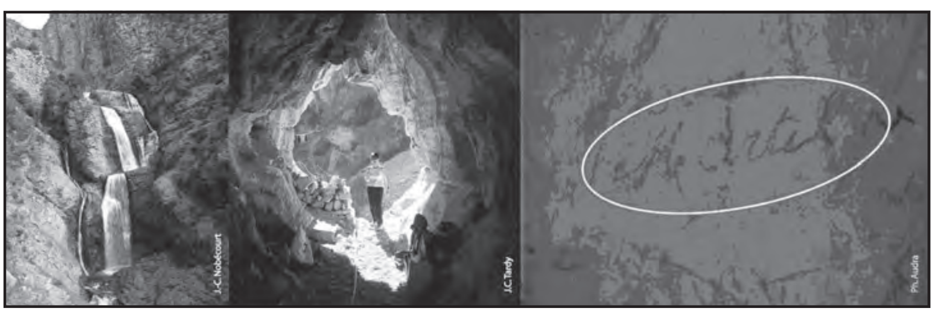

Figure 3: The 60m-high waterfall originates from the Coulomp Spring. Chamois entrance. É.A. Martel signature in the Chamois cave entrance.

squeeze to the window [Barbier 1978].

- **July 1982**: Ch. Peyre (Club Martel of Nice) crosses the 3rd sump and explores upstream up to a squeeze. A survey is done.

3. Hydrogeological Setting

The Coulomp springs locates at 1306 m elevation (Fig. 4). It is probably the largest karst emergence of the Var catchment. Its mean discharge ranges about 1 m^3/s, with low water at 400 L/s, and high water above 12 m^3/s. Its watershed is about 30-35 km^2; it encompasses the Valette and Pasqueires valleys, up to the summit of the Grand Coyer. The Lignin high basin, where lakes are drained by impenetrable sinkholes, probably also belongs to the watershed. This last area belongs to the topographic watershed of the Verdon River, which locates northward.

The aquifer mainly develops in the Cretaceous limestones, which pass upward to marly limestones. Thereafter, the Cretaceous series is covered in unconformity with the Nummulitic trilogy, made of a thin layer of limestone, then of Priabonian marls, and then of Annot sandstone. This famous formation constitutes most of the pyramidal summits. Nummulitic and Cretaceous limestone only outcrop along valleys cliffs (Fig. 2). Consequently, most of the catchment is covered with impervious layers or semi-permeable layers, mainly the cretaceous marly limestone. No karst feature is visible, and infiltration through Cretaceous marly limestone is mainly diffuse. Some discrete sinkholes may occur at the bottom of some valleys, where marly limestone is thin and could provide some concentrated recharge to the Cretaceous limestone. Up to now, the Chamois Cave remains the unique access to the underground karst system of the Coulomp spring.

4. Our Explorations

After several attempts to find the access to the spring, the first exploration was begun in July 2007. Each step needed several attempts, exhausting transports, and perseverance. Four attempts were required to overcome the emptying by gravity of sumps 1 and 2. Then, in October, two dives of the S3 allow us to pass the previous end, and to discover 450 m of new passages of unexpected size: galleries 8 x 15 m and a

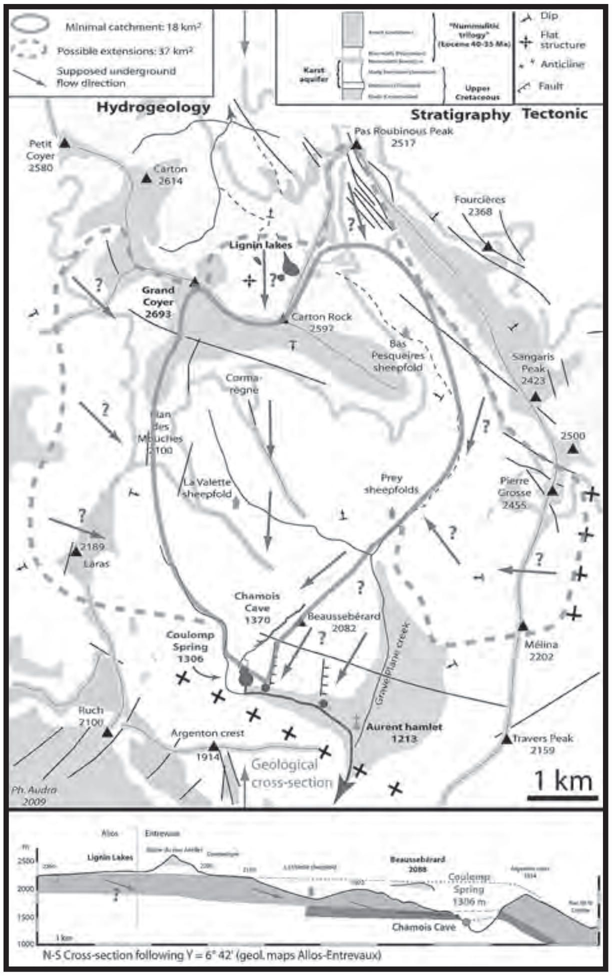

Figure 4: Hydrogeological setting of the Coulomp Spring catchment.

30 x 50 m chamber (Fig. 5, 6). To continue exploration, the S3 needed to be emptied. However, gravity emptying could not apply here, as the flow had to rise up 10 m. By chance, a helicopter allowed us to bring all the required material: a 45 kg weight generator, pump, gas, pipes, electric wires, *etc*. During the 11th of November week-end, the S3 has been drained, a film was shot, and the survey was done to the boulder choke, which closes the downstream part of the fossil passage (Fig. 6). The survey shows that the large gallery almost reaches outside; however, a 20m-thick scree still blocks the passage. Between the end of 2007 and the beginning of 2008, the exploration did not move forward because of high water regularly refilling the sumps. However 8 week-ends were spent to improve our pumping technique and to put safe lines along the dangerous footpath (Fig. 2). In March 2008, a 4-day week-end allows us re-opening the sumps, and a large canyon was discovered upstream. Unfortunately, a rock fell and injured Ph. Audra, who broke his pelvis and several vertebral apophyses, stopping any exploration for a while: 24 hours of rescue, with difficult transport by stretcher across the narrow and wet passages. Due to strong rainfall, exploration only restarted in July 2008, but the sumps remained open until November. About 10 week-ends were required to improve the vertical equipments, to climb some steps, and to survey new passages [D'Antoni-Nobécourt & Audra 2008]. At the end of September, after descending a 16 m shaft, we discovered in one day more than 1300 m of new passages. The huge Hormones Gallery (20 x 30 m) enters about 1 km into the mountain (Fig. 4, 5). We stopped both downstream and upstream only on some small shafts. Since November 2008, heavy rain then deep snow stopped exploration.

5. Pumping Technical

Each sump is drained by 25 mm and 32 mm polyethylene pipes, controlled by gates. The shallow S1 and S2 are gravity-drained, after priming with the pump. A 3 m^3/h pump, located into the S3, is connected by a 300 m-long cable to a 230V generator located outside. The water is flows up 10 m, before flowing outside through a 300 m long pipe. Altogether, the pumping requires between 18 and 30 hours, according to the S3 level.

6. Brief Description of the Cave System

The Coulomp spring discharges cold water (5 °C), pouring out from a low flooded passage about 8 m long. Several

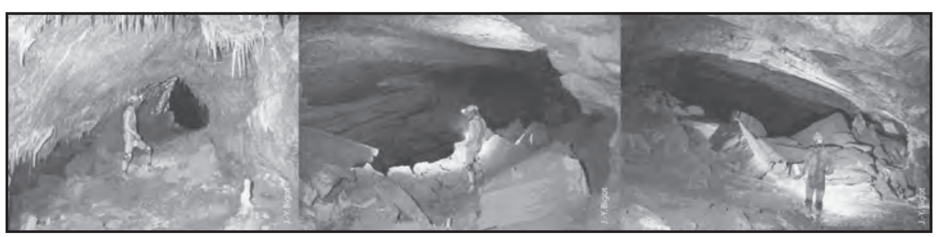

Figure 5: Profile of the Chamois Cave. First crossing of the S2.

Figure 6: Downstream part of the main gallery. Balcony above Diver's Chamber. The boulder choke closing the downstream part of the main gallery.

overflows spread up to 35 m above the spring become active in high water. The Chamois Cave corresponds to an old outflow, located 64 m above the Coulomp spring. Currently, only some percolations feeding the first sump flow out during high water. The first 450 m correspond to underflow passages of the main gallery. They are narrow, with numerous cold pools and moonmilk. S1 and S2 are only fed by surface infiltration. Several times a year, during high water, backflooding occurs in the lowest passages of the system. The water rises about 10 m and floods the S3. After flooding, the passages upstream to the S3 are covered with decantation clay.

After these narrow and wet passages, the scenery abruptly changes: it opens into tubes up to 8 m wide, canyons up to 15 m high, sometimes up to 40 m high when the 3 levels are connected by the main fault. Downstream, after the Divers Chamber (50 x 25 m), the gallery ends on a boulder choke, only at 20 m distance from the surface (Fig. 6). Upstream, several hundred meters long tubes (the Anapophysis Gallery) lead to a 16m-deep shaft, which drops into the Hormones Gallery. The Hormones Gallery acts an overflow passage. It was dry last summer, but it displays clear marks several m^3 discharge during the high water (Fig. 8). Downstream, after some hundreds of meters, a sump closes the active part, while the dry canyon remains unexplored (Fig. 7). Upstream, the Hormones Gallery extends about 1km in a huge passage (20 x 30 m).

During summertime, the airflow originates from the upstream part of the Hormones Gallery, and it disappears downstream across the boulder choke. Part of it may flow toward the Chamois Cave when the sumps are drained.

Figure 7: Diverse aspects of the downstream part of the Hormones Gallery: collapse gallery, scallops, sump.

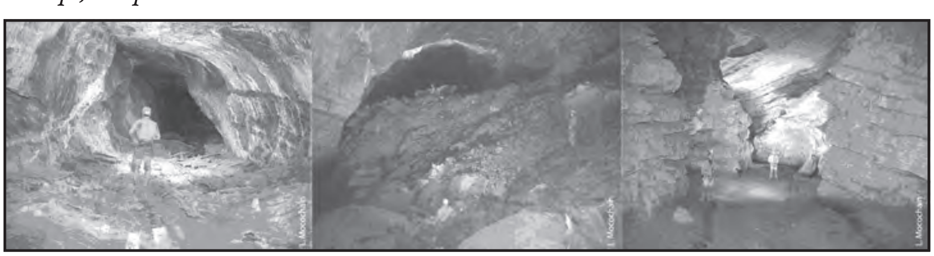

Figure 8: Diverse aspects of the upstream part of the Hormones Gallery: dry tube, huge collapse gallery, canyon.

Conclusion

Currently, the Chamois Cave system extends on 100 m elevation, and 3 km of surveyed passages. During the first year, the pumping hazards and the accident slowed the exploration. The second year provides us the extraordinary discovering of the huge Hormones Gallery. Currently, the pumping is under control; however the access is still restricted by rainfall and deep snow. Our expectations for the future are now turn toward the potential of discovery upstream: the Lignin sinkholes are almost 1000 m higher and 6 km away (Fig. 4). We also expect finally to find the river that pours out at the Coulomp spring. To promote the exploration in this cave we organize in August 2009 an international expedition, which is sponsored by the European Caving Federation (FSE). We hope, not only to increase our discoveries, but also to share our passion for this area of wild nature and demanding caving.

Acknowledgements

The Municipality of Castellet-lès-Sausses, the sponsors (Cozzi, Saint-Cézaire Technique, Société monégasque des eaux), the caving administrations (departmental, regional, the French FFS, and the European FSE). During the accident, the rescue team was composed of Alpes-Maritimes Cavers, Mountains Rescue firemen and policemen, and the helicopter from the civil rescue.

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