

GEOTOURISM POTENTIAL OF UNDERGROUND SITES IN COSTA RICA**POTENCIAL GEOTURÍSTICO DE LUGARES SUBTERRÂNEOS NA COSTA RICA****Andrés Ulloa (1,2) & Carlos Goicoechea (1)**

(1) Grupo Espeleológico Anthros (GEA) – San José, Costa Rica.

(2) Centro de Investigaciones en Ciencias Geológicas, Universidad de Costa Rica (CICG) – San José, Costa Rica.

E-mail: carlos@anthros.org; grupopangeas@gmail.com**Abstract**

Although tourism is presently the main source of income of the Republic of Costa Rica, making an analysis of the offer and demand of the topic of "underground sites as tourist attractions", it is evident that in our country this activity is minimal, with percentage figures that are not even taken into account in the statistics. At government level, there's only one National Park whose focus is caves (Barra Honda); in this aspect, there's also very little and ambiguous legislation. At a private enterprise level, there are only five karstic underground sites worthy of mention, of which only two can qualify as 'business operations'. The other 3 are underground sites to which occasionally and informal visits are launched, but it is still difficult to find references, even in the web.

Key-Words: Caves; Underground tourist; Karst; Limestone; Tunnels, Costa Rica.**Resumo**

Embora o turismo seja atualmente a principal fonte de renda da República da Costa Rica, fazendo uma análise da oferta e da demanda do tema de "lugares subterrâneos como atrações turísticas", é evidente para os autores que na Costa Rica esta atividade é mínima, com percentuais que não são sequer tidos em conta nas estatísticas. No âmbito governamental, só há um parque nacional cujo foco é cavernas (Barra Honda). Neste aspecto, há também pouca legislação, e também ambígua. Ao nível privado, há apenas cinco lugares subterrâneos cársticos dignos de referência, dos quais apenas dois podem ser qualificados como operações comerciais. Os outros três são lugares subterrâneos com visitas ocasionais e informais, sobre os quais ainda é difícil encontrar referências, mesmo na rede mundial.

Palavras-Chave: Cavernas; Turismo subterrâneo; Carste; Calcário; Túneis, Costa Rica.**1. INTRODUCTION**

Costa Rica, despite its small land area (51,100 km²) offers great biological and geological diversity, presenting attractions such as active volcanoes, sandy beaches, waterfalls, reefs, islands, caves and mine tunnels. Some of these attractions are quite exploited by tourism in general (i.e., volcanoes and sandy beaches), others as "adventure tourism" (i.e., caves), while others are potentially exploitable for rural tourism (i.e., mine tunnels). This article focuses on the underground tourist attractions (caves and tunnels) that are currently exploited or could be exploited in the future, which may have a high scenic, geological, historical or educational value.

One of the main economic activities in Costa Rica is tourism, reaching 9,1% of the Gross National Product during 2012 (La Nación, 2013). Tourists who come to Costa Rica are looking mainly for adventure, ecological and nature tourism. Although

many of the country's tourist attractions have strong geological component (i.e., Poás, Irazú, Rincón de la Vieja volcanoes), it is considered that there is insufficient information available as to geotourism in the country and very few studies have addressed these issues (Campos; Astorga, 2010; Ulloa et al., 2011; Bundschuh et al., 2007).

The first National Park in Costa Rica (Poás Volcano National Park) was created in 1971 and since then, gradually an extensive protection system has been established, initially and fundamentally for the protection and conservation of the unique biodiversity that characterizes this small country.

Afterwards, the option of making the Parks available to tourism aroused an activity that, in this specific aspect, still continues to be a function of second instance. According to the National Institute for Biodiversity today approximately 25,1% of the territory of Costa Rica consists of National Parks,

Biological and/or Forest Reserves, Wetlands and other forms of protection, including two parks declared "World Heritage" by UNESCO. Forty four percent (44%) of that total is in the hands of private enterprises, especially in categories such as buffer zones, forest reserves and refuges. For its better management, 11 Protected Areas have been established, which break down to 162 Protected Areas (INBIO, 2013).

1.1. General geological aspects

Costa Rica corresponds to an island-arc caused by subduction, a phenomenon that occurs since the Upper Cretaceous. The recent volcanic arc has a NW-SE axis, with active volcanoes from the North part of Costa Rica to the Turrialba volcano. Between Turrialba and Barú (in Panama) volcanoes exists a gap in the recent volcanic activity; this area corresponds to the Talamanca Range. Also Tertiary volcanism is present (Aguacate Group, Sarapiquí Formation), that presents some ore, with presence mainly of gold and silver (figure 1). These

mineralizations has been exploited (principally as underground mining) since colonial times (Ulloa, 1979).

During the geological evolution, different episodes of carbonate deposition have presented in the forearc, intra-arc and back-arc basins, which led to the deposition of limestone from the Cretaceous to Recent (Figure 1), in which karst occurs (Ulloa et al., 2011).

This geological diversity present in Costa Rica has led to the existence of several underground sites with geotourism potential. Undoubtedly, the most important are caves of karstic origin, but also some volcanic caves have been recognized (none currently exploited for tourism), as well as tunnels (mainly for mining), which have a geotourist and archeological potential. In Costa Rica, approximately 2000 km² correspond to karstic regions (Figure 1) and contain many caves that have been explored since the late 1960's by national and international speleological groups.

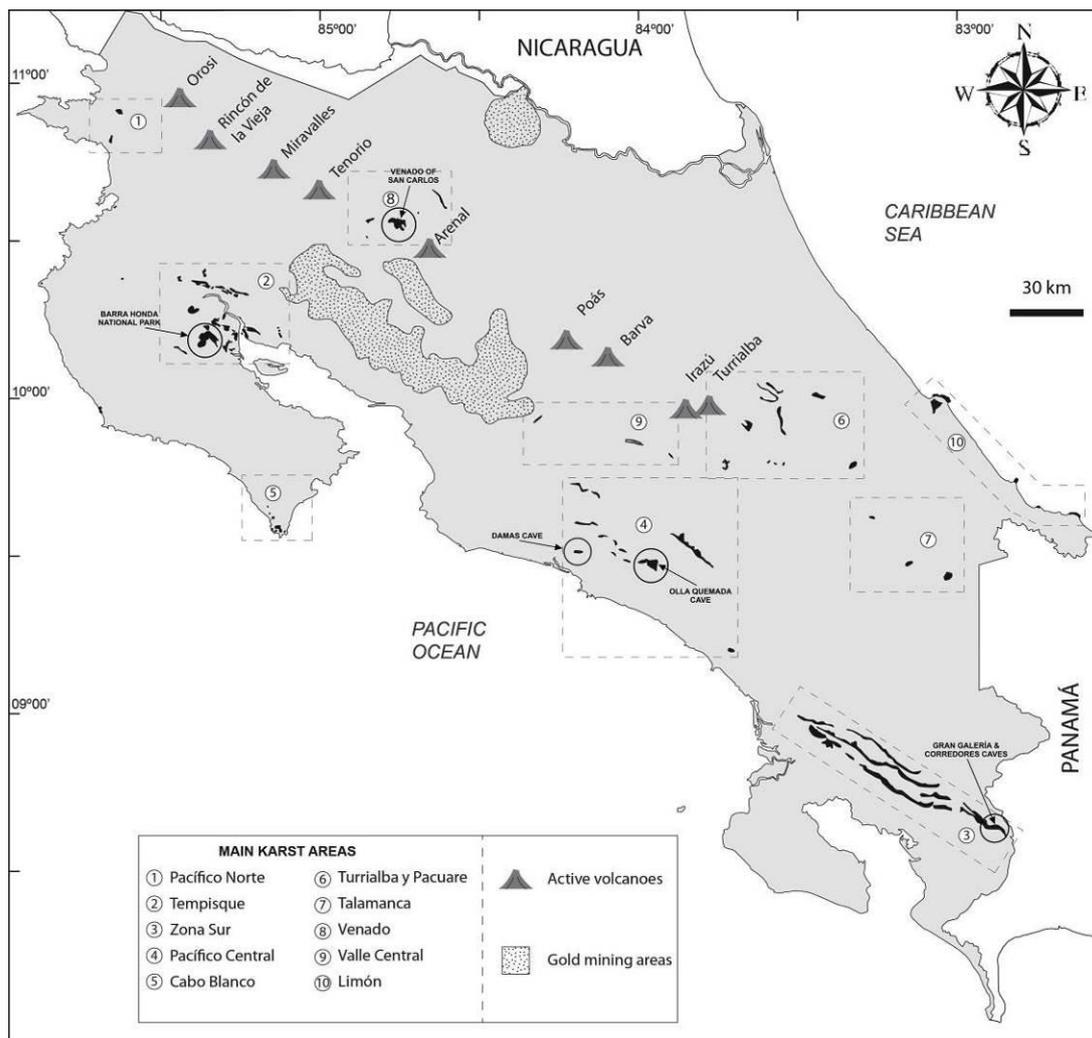


Fig. 1 - Map of Costa Rica showing the different limestone-karst areas, cave sites, active volcanoes and gold mining areas. Modified from Denyer; Alvarado (2007), Ulloa et al. (2011).

1.2. History of speleology in Costa Rica

There are reports of known caves in Costa Rica since the early 17th Century, but it is only after the early 60's that exploration of the caves of Costa Rica begins, with the arrival to the country of renowned French caver Robert Vergnes, who performed the first speleological recognition in Venado cave (a.k.a. Gabinarraca, Venado of San Carlos, Alajuela). During 1967, with the arrival of Catalan caver Juliá González Mateus, the Grupo Espeleológico (GE) is founded, as part of the Mountaineers Club of Costa Rica.

The first karst area that was explored in detail in the country was the Tempisque region (Ulloa et al., 2011), specifically the Barra Honda hills. Both national groups (The GE) and international (Cave Research Foundation, National Speleological Society) participated in these explorations, that led to the creation of the Barra Honda National Park in 1974 (Goicoechea et al., 2009).

Starting in the early 90's, there were important explorations in the south section of the country as well as in Barra Honda: Société Suisse de Spéléologie (SSS), Gruppo Grotte Carlo Debeljak (GGCD) and others (Hapka et al., 1992). In 1995 the Anthros Speleological Group (GEA) is created, which has carried on extensive speleological research, is in charge of the National Cave Register (Speleobase) and has extended its activity to other Central American nations.

The designation of the caves of Barra Honda as National Park marks the beginning of tourism in the caves in Costa Rica, at an enterprise level, with facilities that allow safe visiting for the tourists and for the site. Starting in 1976, cave tours are offered at Gabinarraca Cave (Venado), with a fairly simple infrastructure and gradually, all the others that will be referred-to in this paper.

1.3. Summary of the mine tunnels in Costa Rica

Costa Rica owes its name to the fact that when it was discovered in 1502 by Christopher Columbus, the natives wore many gold ornaments; that was associated by the Spaniards with a wealth that came from placer gold fields, possibly at Costa Rica's South Pacific region (Ulloa, 1979; Durango, 1961). According to Ulloa (1979), there were some mines near the Central Valley that were exploited by the Spanish. Ulloa also indicates that the first accidental discovery of mineral deposits of gold was by the Nicaraguan bishop Fray Nicolás García, in the Montes del Aguacate, Alajuela. Afterwards several other mining spots were opened (mainly underground mining), in different parts of the country (Abangares, Guacimal, Miramar and Aguacate), primarily for gold extraction (Figure 1). Besides Gold, there are other mineral manifestations that have been studied that required tunneling, such as Manganese (steel manufacturing, exploited during World War I), Silver (near the Central Valley and Cartago), Lead and Zinc (Central region and Monteverde) and Copper (mainly in the Talamanca Range & foothills) (Ulloa, 1979; Castillo, 1997). This mining activity led to the creation of several mine tunnels (for exploration and exploitation); according to Ulloa (1979), more than 186 mines and mine shafts were recorded by 1979. Most mining tunnels are in the Aguacate Mountains, Abangares, Miramar, Guacimal and some isolated ones around the Central Valley, Talamanca and Santa Rosa of Monteverde.

2. PRESENT SITUATION OF TOURISTIC CAVES IN KARST AREAS

The main tourist activity in subterranean sites of Costa Rica corresponds to tourist caves. These are distributed throughout the country, in different karst areas (Figure 1). In this section we discuss all the natural sites having tourism in Costa Rica, detailing each one of them, and in a summary. Table 1 shows the main tourist caves of Costa Rica by karst region.

Table 1. Major tourist caves of Costa Rica.

Karst region	Place	Tourist caves	Province
Tempisque	Barra Honda National Park.	Terciopelo and La Cuevita	Guanacaste
Venado	Venado of San Carlos.	Gabinarraca	Alajuela
Central Pacific	Damas of Parrita.	Damas and	Puntarenas
Central Pacific	Piedras Blancas of Pérez Zeledón.	Olla Quemada	San José
Southern region	Ciudad Neily	Gran Galería and Corredores	Puntarenas
Central Valley	Fossil Land, Patarrá.	Abismo Oscuro	San José

2.1. Barra Honda National Park

The Barra Honda National Park (2,295 hectares) is located in the province of Guanacaste. It was created in September of 1974 for the protection of the karst land and corresponds to the only region that has a karst protection status. The park presents some karst features as *mogotes*, karren, travertine waterfalls, sinkholes, springs and more than 50 caves (Wells, 1974; Mora, 1981; NSS, 1989; Ulloa, 2009; Ulloa et al., 2011). This karst area is located in the Barra Honda Formation, and consists of a carbonate platform (Mora, 1981, Calvo & Bolz, 1987) with Upper Paleocene age. Only 29 caves (58%) have been properly cataloged and surveyed. Caves present mainly vertical passages (deepest cave is 125 m); because of this reason, they are difficult to offer as a tourism activity.

The Park has two touristic caves: Terciopelo and La Cueva. Terciopelo cave (Figure 2) was discovered by the Grupo Espeleológico (the GE.CMCR) on February 23 1969, as part of an exploratory cycle initiated by the Group in 1967, which lasted until 1974. In 1973, these hills and the immediate surroundings were studied by the Cave Research Foundation (CRF) and in 1982, the National Speleological Society (NSS) continued

with the work. *La Cueva* was discovered by the GE in 1971. It is located in the central and western part of the plateau of the hill.

Terciopelo Cave is the principal tourist cave in the park. It is a small cave (41 m depth, 92 m length; Figure 2). This cave has a vertical shaft, enabled by a rigid ladder (installed by the *Grupo Espeleológico Anthros -GEA-* in 2004) to facilitate the descent into the cave. The GE also conditioned properly the internal tour trails, which included installing another small internal staircase (Quesada et al., 2006). Climbing equipment is needed (provided), as well as an Official Guide and the Park's Service permission (in advance). The groups are around 10 visitors and the tour lasts about an hour; the attractions are speleothems, the vertical shaft and a small chamber, as well as observing the cave fauna.

La Cueva (the Little Cave) is a very small cave (5 m depth, 17.2 m length). Consists of a single room handsomely decorated, suitable for the visitation of children and 'slim' persons, because its entrance is quite narrow, even after it was extended a bit. As in all of the caves in the Park, the visitors need to enter in the company of an official guide.

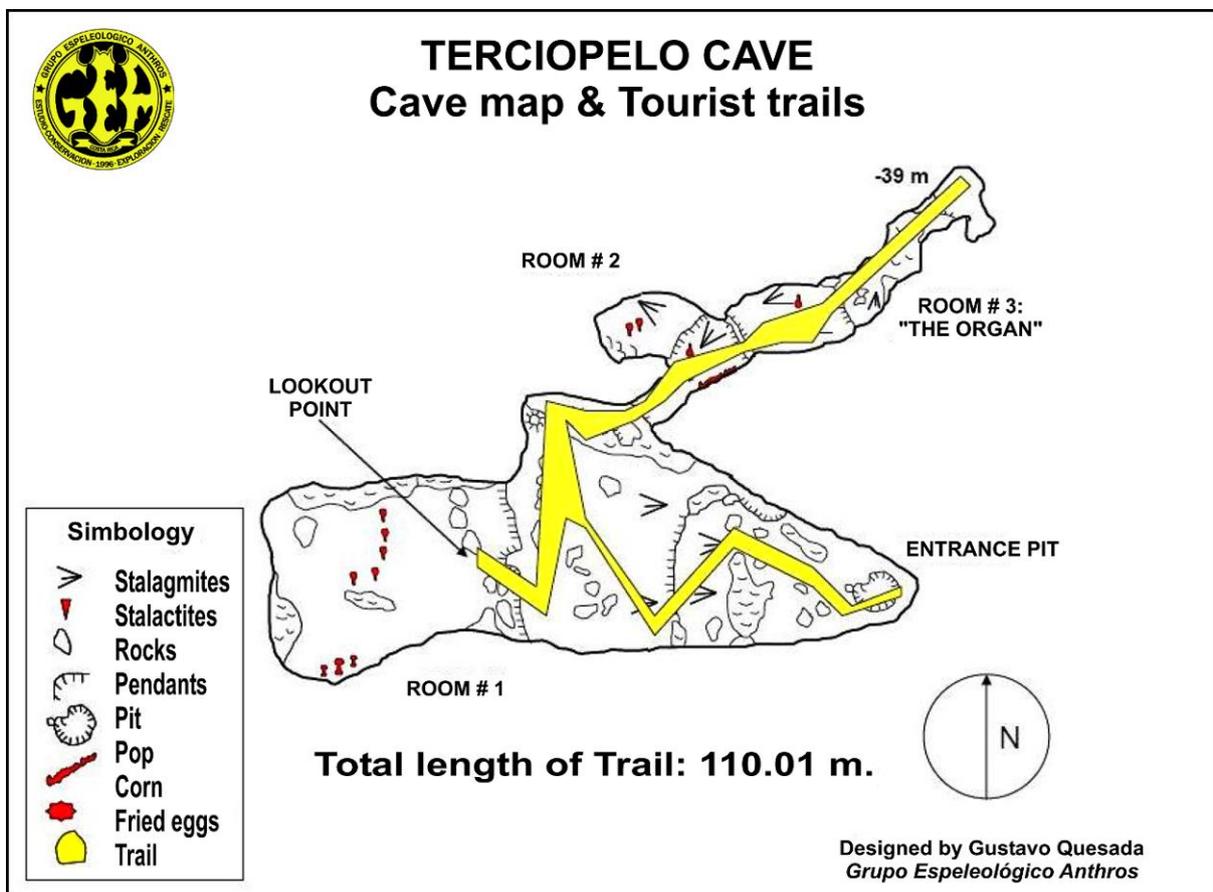


Fig. 2 - Map showing the re-conditioning in Terciopelo cave (GEA, 2003).

The use of this path, allows the visitors to fully appreciate its beauty, without causing major damage.

Barra Honda National Park also offers hiking trails through the tropical dry forest (mostly secondary) and spectacular views of the Tempisque Valley and the Gulf of Nicoya. There are cabins and camping area with drinking water and sanitation. Climate is warm and dry from December through April and then hot and humid for the rest of the year. Any time of year, it can be expected to see howler monkeys (*Congos*), deer, raccoons, peccaries, marten, agoutis and anteaters. Also to observe are 'Rimstone dams' on the East side of the Barra Honda hill, surrounded by secondary forest. The Barra Honda National Park is part of the Tempisque Conservation Area, is open from 8:00 a.m. to 3:00 p.m. and the entry fee is \$ 10 per person (Foreign visitors).

2.2. Venado of San Carlos

The town of Venado is located in the northern-central region of Costa Rica, 180 km from San José. Near to this area are located other geological attractions like Arenal Volcano, hot springs, waterfalls, rivers and lakes. This zone has a karst area of approximately 21 km² and a total of 39 caves have been recognized in it (Speleobase, GEA, 2013). The limestone belongs to the Venado Formation, is stratified and associated with a carbonate sand bar system (Obando, 1986; Calvo & Bolz, 1987). This formation has an age of Middle to Upper Miocene (Malavassi & Madrigal, 1970; Sem Gupta et al., in Obando, 1986). Some karst features are conic karst, springs, sinkholes, dry rivers, blind valleys and caves systems (Ulloa et al., 2011).

In this region the main economic activities in the area include dairy farming and the production of sugar-cane, pineapple, oranges and tubercles. Cave tourism is one of the main attractions; one can visit Gabinarraca Cave or as it is popularly known, Venado Cave. This cave seems to have been known by the Guatuso aborigines that inhabited the area; however, so far no evidence has been found associated as to them visiting or using the cave. The cave was re-discovered around 1948 and its technical exploration started in 1968, by the *Grupo Espeleológico*. This cave was also explored in the 80's by geologists looking for oil and coal in the area, by the NSS on an expedition in 1991 and by *Grupo Espeleológico Anthros* cavers, starting in 1996 till the present day.

Gabinarraca cave is the biggest cave of Costa Rica (2741 m length and 41 m of height difference). It is a cave with five entrances, with passages that

have an interlocking pattern, with dry and wet sections. It has at least three vertical levels, the lower generally corresponds to the wet sections (Figure 3). The main attractions are speleothems (stalactites, stalagmites, columns, flowstone, curtains, etc), large colonies of bats, underground fish, amphibians and insects, such as spiders and crickets. The average temperature inside the cave is 22 °C.

Tour operations were formally launched in 1976, reaching in 1996 a peak close to 500 visitors per week. Derived from a problem with some tourists becoming infected with Histoplasmosis in October 1998 (61 children and 14 adults), the cave was closed for a couple of months. From that date on, the number of visitors dropped to about 500 visitors per month. Presently, the owners provide and recommend the use of paper masks. The site counts with adequate infrastructure, such as toilets, showers and a large saloon that serves as lounge and restaurant (meal services have to be previously requested).

The Administration usually keeps 2 or 3 permanent guides, but in case of tours with many participants (reservations required), they summon additional guides. The duration of the tours is approximately 2 hours, with a maximum of 10 to 12 individuals. Regular tours do not cover the entire cave, but a just a selected portion. Signs indicating where the exits are have been posted, in case of an emergency evacuation. As part of the entry fee a clinical type mask is included, to cover nose and mouth, in order to avoid possible infection by Histoplasmosis. Its use is optional. All visitors, at the conclusion of the tour, are advised to take a shower and change clothes. The schedule is every day from 7 a.m. to 5 p.m. Camping is allowed on the property. There are also several informal restaurants in the town of Venado, just 2 km away.

2.3. Central Pacific: Damas and Olla Quemada caves

The Central Pacific karst region (Figure 1) presents 57 km² of limestone, in which so far eight caves have been recognized (Ulloa et al., 2011). In this area, the layers of limestone are not very extensive and the main karst manifestations are sinkholes, springs and caves. The limestone has been defined as Middle Eocene in age, according to Malavassi (1961). Two tourist caves are the ones of our concern: Damas and Olla Quemada.

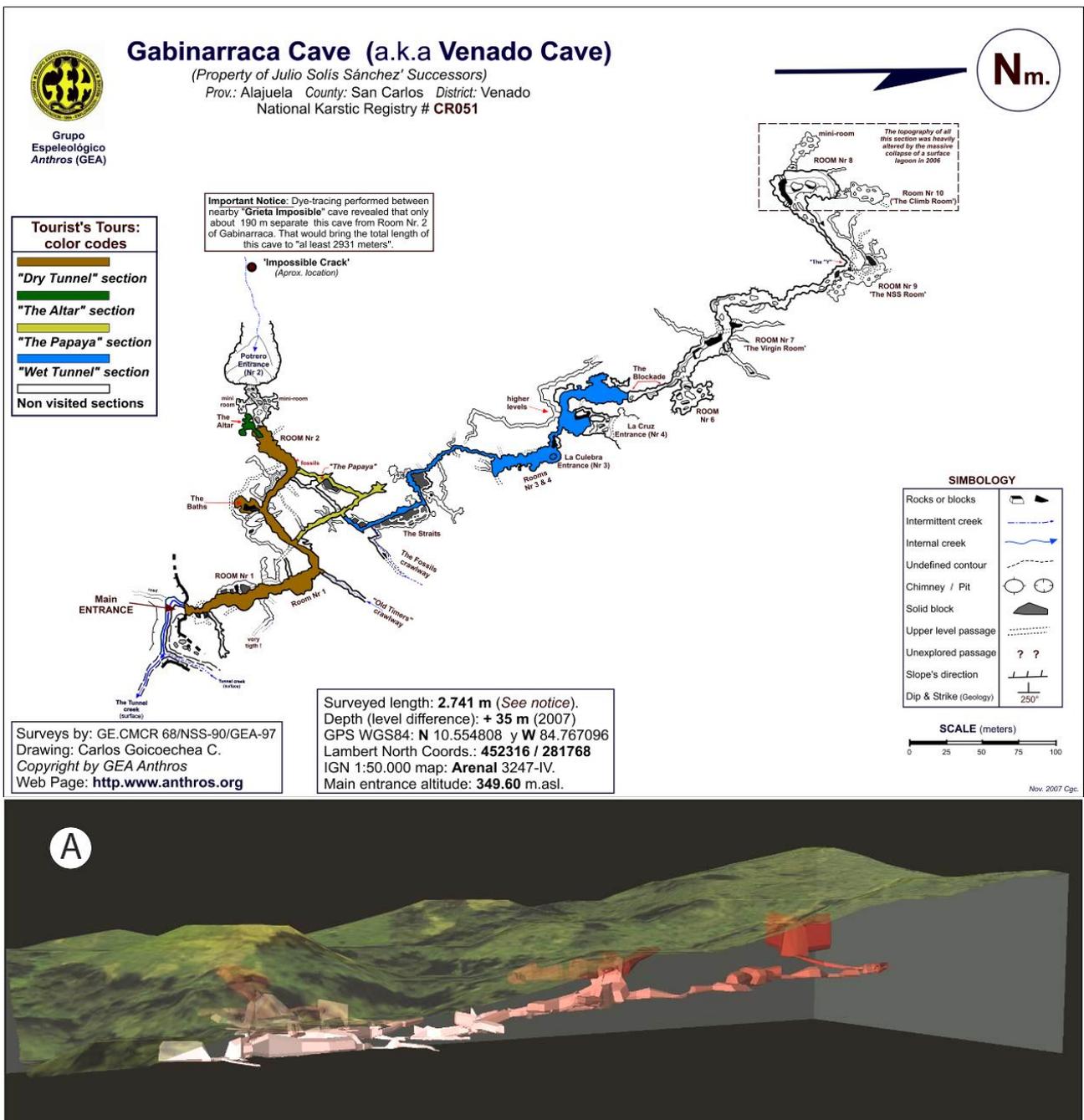


Fig. 3 - Map of Gabinarraca Cave, indicating in color codes the passages that are open to tourism. The 3D image shows the shape of the cave, related to the surface features. Modified from (GEA, 2007).

Damas cave is located 16 km northwest of the Quepos (touristic town) and 9 km to the north of the *costanera* road (CR-34). It became known in recent times, circa 1925. In 1960, the first cave map was drawn, using only a compass and tape (Contours not shown). During October 2006, GEA cavers and a member of the NSS surveyed the cave in detail. This cave presents 286.4 m in length and 21.6 m of depth. The cave has 3 entrances. Damas Cave (Figure 4) is named after the Damas River, which runs just outside the cavity, on its NW flank. No water circulates inside, but there are some sections with mud and puddles. This cave is horizontal and

relatively easy, but has some crawlways that are quite narrow. It is the home of thousands of bats; a species caught was identified as *Saccopterix* sp. There are many spiders, crickets, cockroaches and other troglobite insects that live permanently in it. Until the end of 2006, the cave was shown in tours to organized groups of visitors, offered by the owners of a small private reserve (356 hectares). The full day tour included horseback riding and other activities, such as trekking and bird-watching. Some nearby outdoor river pools allow for a refreshing swim (ESCAPE VILLAS, 2013). Presently, the farm seems to have new owners that allow visiting.

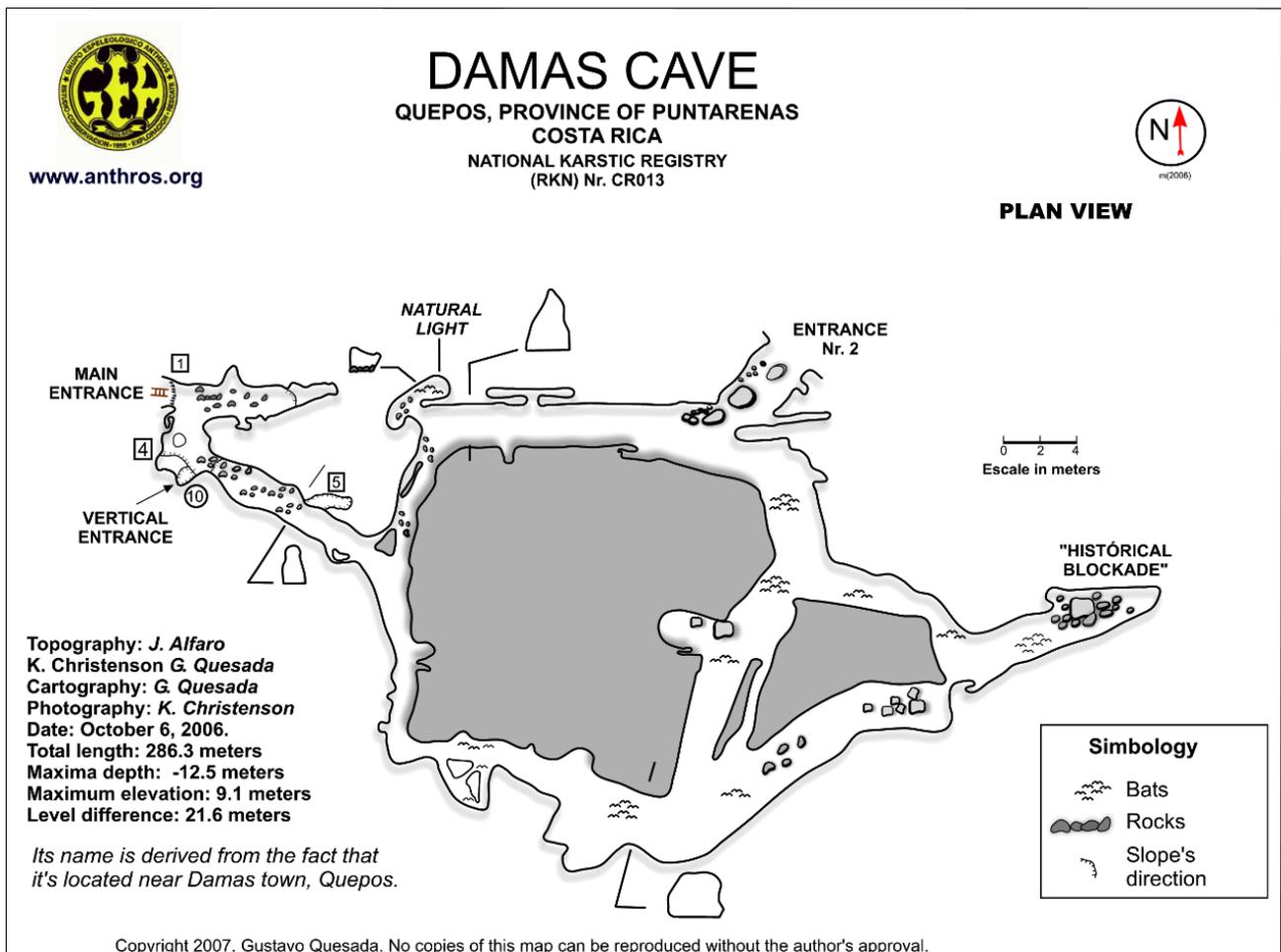


Fig. 4 - Map of Damas Cave (GEA, 2006).

Olla Quemada cave is situated in the limestone hills that rise south of the small town of *Piedras Blancas de Brujo*, on the south bank of the Savegre River, about 37 linear km WNW of the port of Quepos, an important tourist destination. *Piedras Blancas* can be accessed only by hiking or a horse ride; there are three possible routes: *Cerro Nara*, *el Brujo* and *La Chaqueta*; all require hiking through the tropical forest. A local guide is needed to reach the cave and the final route up to the cave is a rustic trail, in which even horses have difficulty going up. This cave has been known to scouts and locals since around 1985, but was re-discovered by some members of the Costa Rican Speleological Association (AEC) in September 12, 1987. Carlos Goicoechea drew the first 'sketch' of this cave. In August 2009 the cave was visited by Keith Christenson, of the NSS, who located it with a GPS and provided some modifications to the initial sketch map. During 2010, GEA performed another survey and completed the exploration of the entire cave (Figure 5). A total depth of 57 m was reached, besides completing the map of the 346 m of its length.

Olla Quemada cave does not exhibit a profusion of formations, except in the Hall of

Columns and there are some passages with an important amount of sediments. The main entrance is inclined and opens 1.40 m above the ground, at the base of a muddy wall. It has 4 meter wide and 1.40 m high, surrounded by jungle. Entrance Nr 2 is a sinkhole about 2 m in diameter that drops 12 meters to the cave's floor. After this entrance opens Room Nr 1 on the left side (Esperanza Room, aka the Column's Room), which ends in 2 chimneys that lead vertically to the outside. Following a fairly straight line, the visitor continues along the main passage, up to 10 m high, passing on the left side by Room Nr 2 (Don Lulo's Room) and then on forward to Room Nr 3. Here starts a narrow dirt-floor gallery, with a low ceiling (2 m high), which leads to Room Nr 4 (The Dome Room), up to 10 m high. At point 'C' (on the map), on the right side, starts a tight fracture, at the end of which opens 'Andy's Crawlway', only 0.40 m high. This catwalk becomes vertical, shaping into 3 short consecutive tight pits - (5, 4 and 8 m)- that sort of "corkscrew" down to a point where one can not go on any further. Tourist tours correspond to the main passage. There is also much guano throughout the cave and bats, spiders, crickets and similar insects. The cave is located in an area where the primary forest has been rather

intervened by agriculture and livestock practices developed by residents of neighboring communities. That could account for the eroded material. This cave is in a private property, owned by Neftalí Granados Elizondo, a resident of Piedras Blancas of Savegre.

This whole area is beginning to organize for the proper reception of tourism. COOPESAVEGRE (a Cooperative) has outlined a comprehensive plan entitled "Agro-ecotourism as a source for the improvement of the revenue to the inhabitants of the Savegre River Watershed". There are many lodging options, varying from tent camps to hostels, with optional food service. Tours for foreigners are advertised in the Web (The Costa Rica online, 2013).

2.4. Southern Region: Grand Gallery and Corredores caves

This region is the one that presents more karst surface (185 km²) and caves (156); located in the Southern Region of Costa Rica, it presents many limestone outcrops along the *Fila Costeña* Range (Ulloa et al., 2011). These limestone beds correspond in age mainly to Middle to Upper Eocene, according to Malavassi (1961) and a few to the Oligocene limestone (Yuan, 1984). The main karst features in the area correspond to sinkholes, dry rivers, blind valleys, karren, karst springs and travertine waterfalls.

There are two tourist caves: Grand Gallery and Corredores. Both are located on the SW flank of the *Fila de Cal* (in *Fila Costeña* Range), in the environs of Ciudad Neily. The Grand Gallery cave is the only one that offers organized tours. Corredores cave is visited by the annual speleological course of Grupo Espeleológico Anthros, and some occasional visits by locals and occasional foreign tourists.

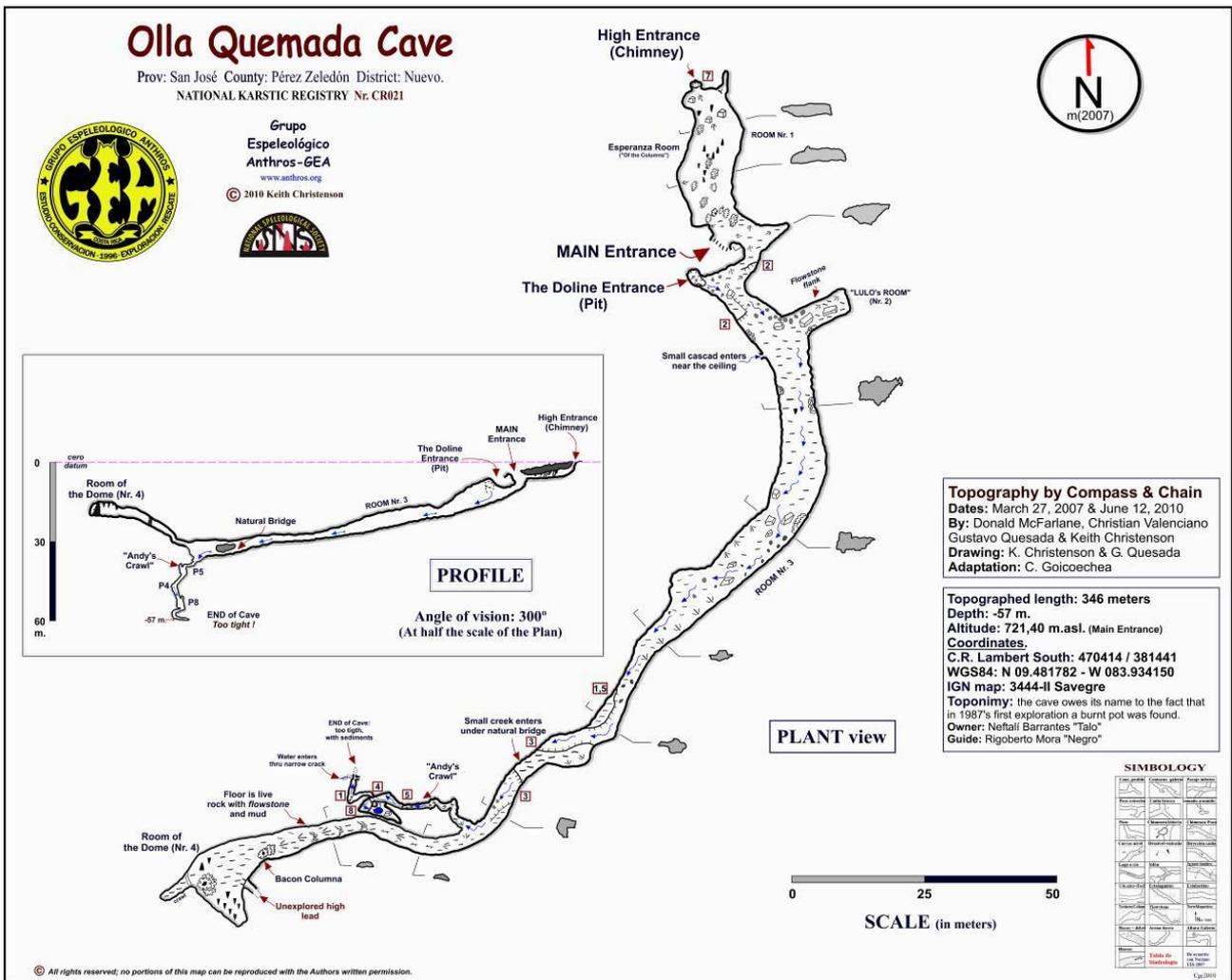


Fig. 5 - Map of "Olla Quemada" cave, drafted by GEA and the NSS between March 2007 and June 2010 (GEA, 2010).

Grand Gallery cave is located in the base of a cliff, inside a large sinkhole and present 3 access points. The cave was locally known, but was re-discovered by Gordon McCracken and Carlos Goicoechea in 1989. The farm where it is located belonged to a Panamanian nicknamed "Chiricano" (Jorge Vidal), but he sold it some years ago to Alvis Mora Salas. This man built a large house near the cavity and is starting to offer it as a "show-cave". For now, there is already a good path open to the entrance. This cave has 148 m length and 26,4 m depth, according to the NSS map (Figure 6). There is no running water inside the cave presently, but it is speculated that in the past the water of the Quebrada Seca (Dry Creek) flowed into this cave (Peacock; Hempel, 1993).

The tours offered in Grand Gallery cave include visiting the nearby Quebrada Seca sink and optionally, the entrance to a cave that is located at the sink-site, named Macameca. During the visit, a good description of both the flora and fauna that characterizes the region is provided by a professional in tourism. It can also be reached by means of a 26 m rappel from the top of the cliff atop the cave, an activity provided with an extra expenditure.

The business that manages the cave operates a web-site where there are information on topics such as wildlife and other appeals included in the tours, as well as accommodation and food facilities in the neighboring Ciudad Neily (Cavernas Guayabí, 2013). These tours have duration of 5 to 6 hours, the cost ranges from \$ 20 (minimum 2 people) to \$ 50 (single person). It is required to fill-in and sign a liability release form by the tour operator.

2.5. Abismo Oscuro cave (Dark Abyss)

This facility is situated at Quebrada Honda of Patarrá, about 10 km South of San José (30 minutes drive). It is within the *Fossil Land Complex*, on the farm of Otto von Schroeter. This region only has 6 km² of limestone outcrop and there are reports of only six caves (Ulloa et al., 2011). This is a bioclastic limestone, with abundant fossils (principally *Pecten* sp.) and of Miocene age. In general, there are some incipient karst features, like small caves (Ulloa et al., 2011). Fossils abound throughout the park, but especially on a large wall that is showcased to the tourist, where they can dig their own "souvenirs". This segment presents only one tourist cave, named *Abismo Oscuro* (Dark Abyss), also known as "Captain Tula's Cave" and / or Patarrá Pit.

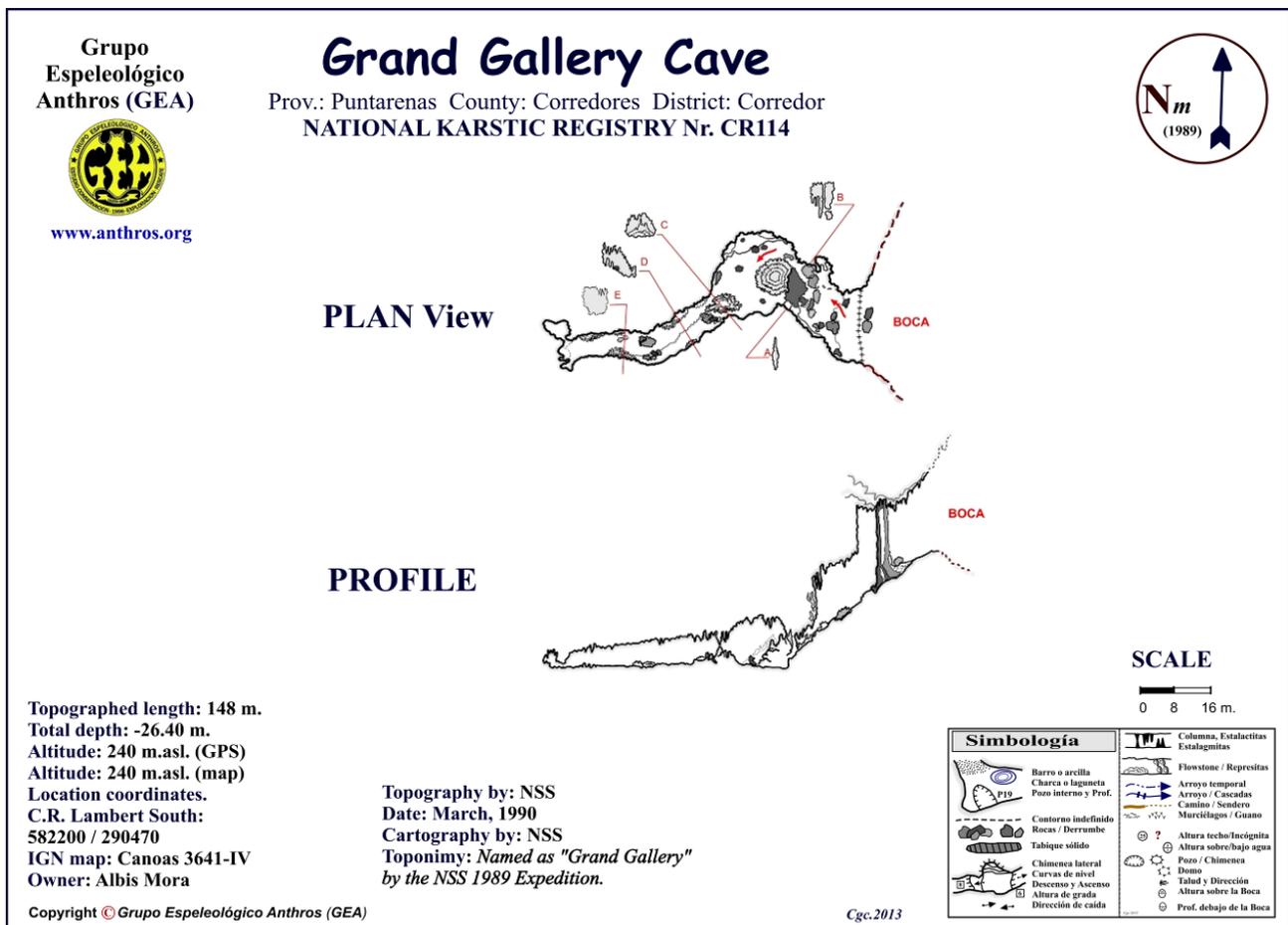


Fig. 6 - Profile and plant map of Grand Gallery Cave. Modified from Peacock; Hempel (1993).

Dark Abyss cave is small (69.5 m length and 24.1 m depth). This pit was probably discovered by a laborer of the von Schroeter farm, on an unspecified date. As early as 1968, there were speculations about 'chasms' and caves in this area. It appears that journalists from TV Channel 6 (REPRETEL, "The Explorer"), back in 2000, wanted to film and photograph the cave. This led to a power plant being introduced inside the cavity. The obvious results were air contamination and all of them had to be evacuated in an emergency. The *Asociación Espeleológica Costarricense* (AEC) apparently visited the site in 2002, but without issuing a report or sketch. GEA explored and surveyed it on July 2010 (Figure 7), and since then it is used as a practice site added to the caving courses that are taught. Proprietor is Mr. Otto von Schroeter (and family).

"Fossil Land" keeps the place clean and has suspended the extraction of limestone in the area where the cave is located. There is entirely no water inside the cave, except that which enters during rainfalls. Air circulation inside the cave isn't ideal, gases seem to pile-up and stagnate, but not to the point of being critical. The venture's owners have installed three metal ladders, so no rope work is necessary, unless one wants to avoid the use of them and have fun on-rope. The site is a tourist operation

since October 2001 and has a web page site (FossilLand, 2013). Among the attractions, it offers abseiling (rappel), caving, canopy for children, mountain bike, ATV, paintball, geological tours, climbing, camping and hiking. The Park is open Monday through Saturday, with previous reservation. On Sundays it operates from 9 a.m. to 4 p.m. The fares range from \$ 11 to \$ 67, depending on the amount of people and the number of attractions booked. Fast foods services have also been implemented.

2.6. Other tourism potential karst areas

There are some caves that are close to presently operating tourist places that have occasional visitation, which could well be used entrepreneurially for such purposes, according to its localization. La Capilla cave opens in Portete, close to the Port of Limón area; presently there's an on-going development of it as a modern port, with heightened tourism opportunities. Although historically it is mentioned since 'the 70's', it was not until 1994 that the *Centre d'Etude du Karst* inspected it (Guilli et al., 1994), but according to their description it was collapsed after the *Limón* earthquake, and has low tourism potential.

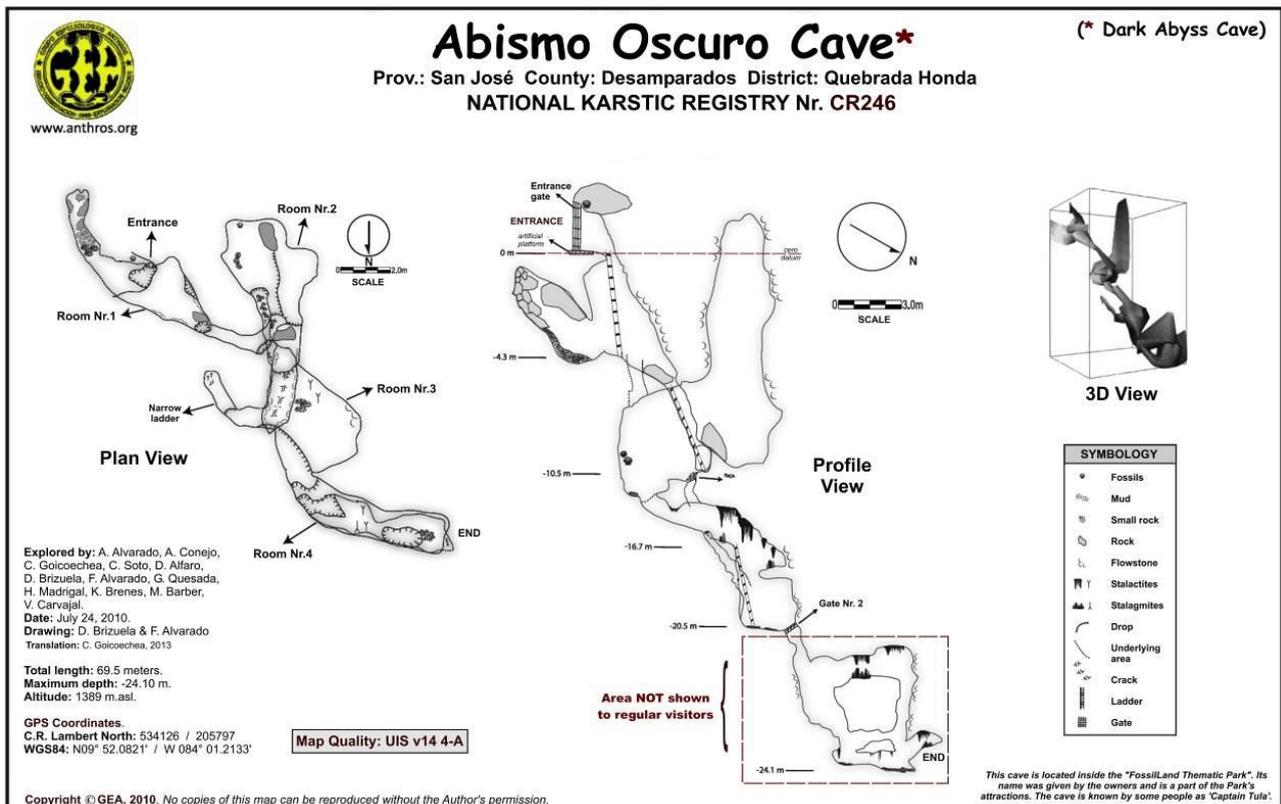


Fig. 7 - Plant and profile of the 'Dark Abyss', located in the "Fossil Land Tourist Complex", in Quebrada Honda of Desamparados, San José (GEA, 2010).

Malpaís is a rocky and sandy beach, located on lower western flank of the Nicoya Peninsula and frequented mainly by surfers. This is a small area with karstic signs (5 km²) and according to Calvo (1987) the limestone is of Middle-Upper Eocene age. Anthros Speleological Group (GEA) has located, explored and surveyed some small sized caves: *Peñón cave* (a 16.6 meter long 'V'-shaped cave, with a sand & pebbles floor), *Pochote-115* cave (34.2 m long and 5 m depth), *La Grande* cave (The largest, 112 m long and 18 m deep, located inland); a beach rock-shelter is also present. This group of caves or grottos, located within a 200 by 250 meters area which lies between the Pacific Ocean and some small limestone hills that rise next to it, are a local attraction and are sometimes shown to tourists. There is no understructure at all, but they are located on a Protected Land Area (*Refugio de Vida Silvestre Cueva de Los Murciélagos*), which is part of the Cabo Blanco Absolute Natural Reserve. The largest ("La Grande".) is perhaps the only one worth while a visit of this type, since it consists of a larger 20 by 15 meter central room, out of which originate 3 galleries, the largest about 22 m long. It is fairly decorated, but has suffered a bit of vandalism.

3. OTHER NON-KARSTIC UNDERGROUND SITES WITH TOURISTIC POTENTIAL

3.1. Mine tunnels in Costa Rica

As discussed earlier, mining extraction of metals led to many mine tunnels being dug in different mine districts along Costa Rica. Among those tunnels, some are abandoned and others are still exploited, principally for artisanal mining (small-scale miners and "*coligalleros*"). As a result of this activity, in the highest production areas were left a large amount of tunnels and/or perforations, which reached important dimensions in both the horizontal and the vertical aspects. A few have been conditioned as tourism resources, in which the attractive of the perforations and other charms of the sector are combined, such as rivers, forests, swimming holes & pools, horse riding, ATV rentals, museums, etc. Incipient examples of this are happening in several places.

Where the Union Mine operated, in Desmonte of San Mateo (Alajuela), a small fee is charged for visiting 150 meters of partially illuminated and rustic mining tunnels, combined with the sale of meals and the opportunity to take a dip in the mountain stream that runs just alongside the tunnel. Parking and souvenir stores are available.

In the city of Abangares (Guanacaste) is the "Eco-Museum of the Abangares Mines", which displays large amounts of the machinery used in the extraction and transport of gold material. Right there was the largest operation center of the Abangares Gold Fields Company.

3.2. Topolandia Tunnels, San Pedro de Pérez Zeledón

The information available so far is limited. It's located on a 25 minutes drive from downtown San Isidro de Pérez Zeledón (Province of San José), on the Inter American Highway (CA-2). Upon reaching this town, it's 1 km to the northeast from the intersection of the secondary road that leads into San Pedro, adjacent to the Bailey bridge over the San Pedro River. "Topolandia" consists of artificial tunnels in weathered alluvial fans, some with chambers up to 15 m deep. In several artificially made and interconnected tunnels (Figure 8), the owner of the property has established a museum, exhibition hall, conference room and other facilities. Open all year round, 8 a.m. to 5 p.m. Fees: \$ 4 adults and \$ 2 children. It advertises 'controlled temperature' (between 18 ° and 24 ° C), mineralized drinking water from 2 wells (15 m deep pond), sculptures, stone beds, bathrooms and outside recreational areas. The tour lasts for 1 to 2 hours (Jara, 2013)



Figure 8. Aspect of part of the facilities at "Topolandia", seen from across the access road (Jara, 2013).

4. DISCUSSION

In Costa Rica, the use of caves for tourism purposes is a fairly recent activity. It began in 1974, with the declaration of the Barra Honda hills (Nicoya, Guanacaste) as a National Park, in order to protect the 50 caves discovered to that date. Even before this, some caves in different parts of the country were visited locally during holidays and

special occasions. Around 1976 starts the offering of tours at the Venado Cave, in San Carlos of Alajuela, and around 2002, 'Fossil Land Recreational Park' opens, in Quebrada Honda of Desamparados (San José). Late in 2010, Grand Gallery Cave, in the southern zone of the country, joins the tourism offer. More recently, informal tours to Olla Quemada Cave (Savegre River, San José) began to be carried out, but without any special organization. Other caves, like Damas Cave, in Parrita and Corredores Cave, in the county of the same name (Both in Puntarenas province), are occasionally visited by tourists, both foreign and national, but there is no operational structure. Therefore it can be said that, although tourism is nowadays the largest source of national income, the share corresponding to 'cave related tourism' is quite low, representing an almost negligible part of the total.

A comparison of Costa Rica's tourist caves is presented in table 2.

Even though, in the aspect of 'using caves as a means of promoting tourism', the undertaking should come from the private sector, *Grupo Espeleológico Anthros* (GEA) -a non profit organization- is visualizing the option of proposing to the proper government officials that several specific karst areas be declared as "protected land". This project, nevertheless, is in the preliminary stages. There is a special interest in protecting the caves around

Ciudad Neily, because there are some important karst systems, such as Quebrada Seca, Carma and La Bruja/Corredores, which have important springs.

Presently, Carma cave is a source of drinking water and is under partial administration by the local municipality and the AYA (National Water Administration Institute). This area covers an extensive basin, where several large caves open and has a hydrological connection with the next 'proposed' area, which drains into the Corredores River: the fault-line segment where the Quebrada Seca area caves are located, such as Grand Gallery and Macameca. This project should also comprise the "Bruja / Rectángulo / Tururún / Corredores System" (Corredores county, southern part of the province of Puntarenas).

ACKNOWLEDGEMENTS

This work couldn't have been properly accomplished without the dedicated assistance of fellow cavers Ferdinando Didonna, Gustavo Quesada and the totality of the associates of *Grupo Espeleológico Anthros* (GEA), dedicated since 1996 to the study of the caves & karst of Costa Rica and Central America. A special acknowledgment to Gustavo Quesada for compiling the information of table 1.

Table 2. Comparison of characteristics of the studied caves.

Data	Gabinarraca	Gran Galería	Abismo Oscuro	Olla Quemada	Terciopelo	La Cueva (Grotto)
Visitors per guide	1 guide for up to 15 visitors.	1 guide for up to 10 visitors.	1-3 guides per group.	1 guide for up to 10 visitors.	1 guide for up to 10 visitors.	1 guide for up to 10 visitors.
Artificial light	No	No	No	No	Yes	Yes
Safety gear	Helmet, helmet-fixed light and rubber boots.	Helmet and light.	Helmet and a handheld flashlight.	No gear at all is provided. Flashlight used to be loaned.	Helmet, harness, belay rope & first aid kit (Carried by the Guide).	Helmet & first aid kit (Carried by the Guide).
Approx. number of visitors	Presently: 500 by month. In 1996-97: 500 per week (Aprox.).	N.A.	4600 persons p/ year (2012 data).	100 persons per year.	3600 visitors per year.	Around 120 visitors per year.
Tour duration	1 to 2 hours	45 minutes to 1 hour	25 minutes	2 hours	1 hour and 30 minutes	45 minutes
Source	Owners and experienced local guide.	Local guide with experience.	Fossil Land Adventure Park.	Local guide with experience.	National Park Administrator	National Park Administrator

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Editorial flow/Fluxo editorial:

Received/Recebido em: 19.may.2013

Accepted/Aprovado em: 27.sep.2013



TOURISM AND KARST AREAS
(formerly/formalmente: Pesquisas em Turismo e Paisagens Cársticas)
Brazilian Speleological Society / Sociedade Brasileira de Espeleologia (SBE)

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