
Contribution to the Vulcanospeleology of the Galapagos Islands*

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Abstract

During April and May 1990 and March and April 1991 the Museo de Ciencias Naturales of Tenerife (Canary Islands) carried out two expeditions to Galapagos Islands, within the framework of the Project "Galápagos: Patrimonio de la Humanidad," on the occasion of the Fifth Centennial of the Discovery of America. We present here the first results of the speleological research, consisting of the location and topography of seven new caves—two pits in Isabela Island (Cerro Grande and Las Torres) and three lava tubes and two pits in Santa Cruz Island (Elena, La Micon, and Casajo Caves and pits known as La Pirámide and Pozo de Los Gemelos). Among these Cueva del Casajo is really notable; with its length of three kilometers it is undoubtedly the longest lava tube of the Archipelago. We present the maps of these caves, as well as information about their geomorphology, state of preservation, location, and means of access. A list of all Galapagos volcanic caves known to date (a total of 50 caves) is shown and an up-to-date speleological view of this archipelago is discussed.

Introduction

Stretching across the middle of the Pacific Ocean, 972 kilometers off the coast of Ecuador, there lies an extraordinary island group covering some 8,000 square kilometers. It is made up of 19 islands, 42 islets and 26 rocks (Figure 1).

The islands extend over an area of some 320 kilometers from east to west and a bit less from north to south. They connect with South America via the Carnegie underwater ridge and with Central America by means of the Cocos underwater ridge. Their volcanic nature gives the islands a beautiful and varied landscape, where hundreds of slag cones, a multitude of basaltic lava flows, and spectacular sunken calderas predominate.

Since Darwin's visit to these islands in 1835 they have truly become a milestone in the historical evolution of scientific thought. The special geologi-

cal nature of these islands as well as their extraordinary vegetation and fauna (especially vertebrates) has always attracted the attention of a great number of researchers.

However, despite all this interest, the abundant volcanic caves that exist on the islands and the enigmatic subterranean wildlife have been, until

*This study is part of the project called "Galápagos: Patrimonio de la Humanidad," carried out by the Museum of Natural Sciences of Tenerife, under the direction of Dr. Juan José Bacallado Aránega, with sponsorship of the Island Council of Tenerife, the Tourism and Transportation Council of the Canarian Government, and the Commissions, both National and Canarian, established to participate in the activities that will take place in commemoration of the Fifth Centennial of the Discovery of America.

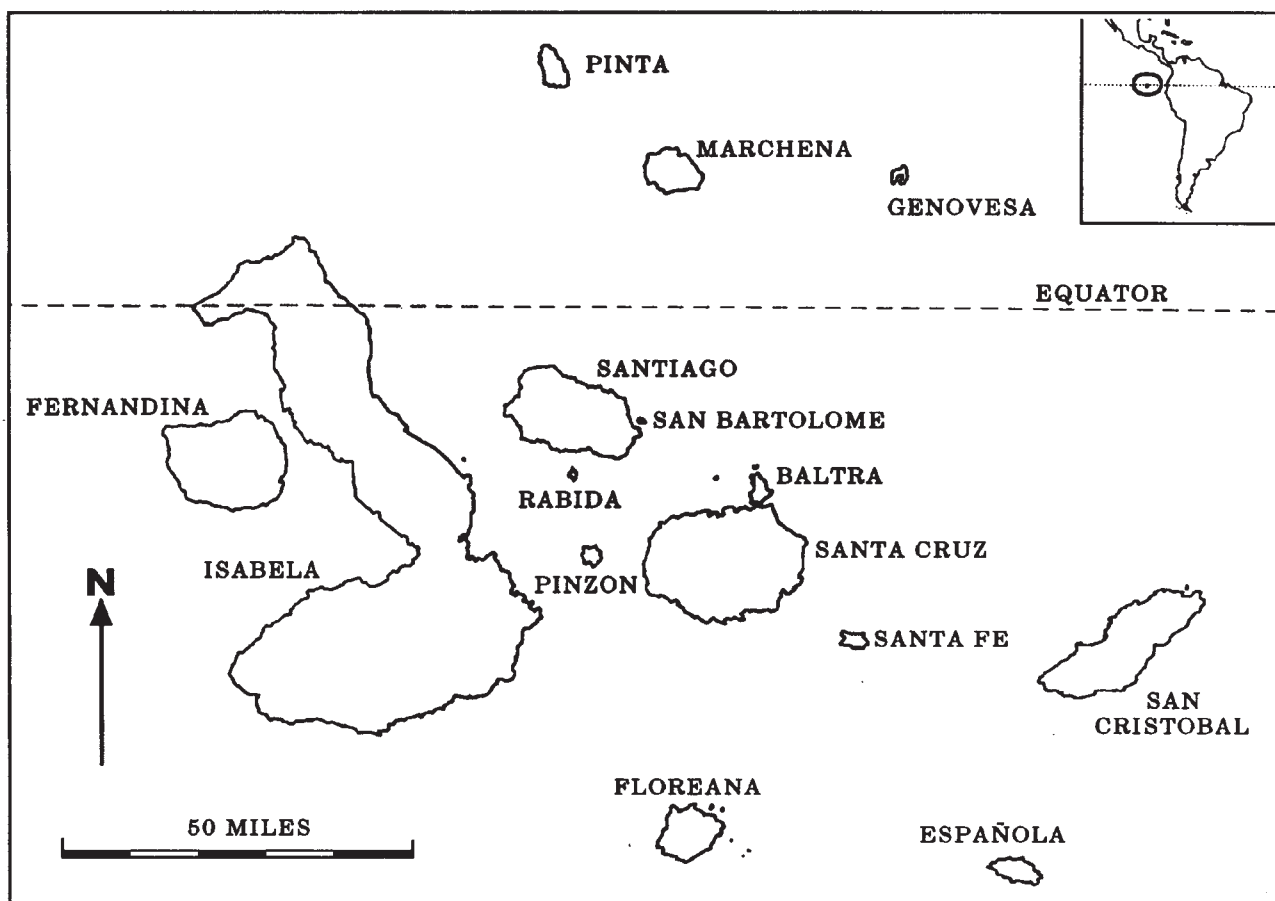


Figure 1—The main Galapagos Islands.

just a few years ago, unknown to the international scientific community.

This study represents an attempt to provide more knowledge about the interesting vulcanospeleology of these islands, which hold many surprising secrets yet to be revealed.

Background

Although Darwin cited the existence of certain caves on the island of San Cristobal (Darwin, 1845) during his visit to the Galapagos, we believe that it was the "Mission Scientifique Belge aux Galapagos" in 1962 that deserves the honor of being recognized as the pioneer of speleological studies on these islands. The first contributions to speleology coming from these islands were made by G. Stoops and P. De Paepe, who participated on this expedition and who published two brief reports in 1965 (Stoops, 1965; De Paepe, 1965) about a cave located near Puerto Ayora (Island of Santa Cruz) and which is unmistakably known today as Kübler Cave.

In 1970 the Hungarian speleologist, Denes Balazs, mapped this cave as well as another cavity, named after him, located near Bellavista (Santa Cruz). Five years later his studies were published (Balazs, 1975). It was in this year that an expedition called "Galapagos '75" was undertaken, the first Spanish speleological expedition to be carried out on these islands and whose results have been reported in three publications, about the islands of Floreana (Montoriol-Pous and Escola, 1975), Santa Cruz (Montoriol-Pous and De Mier, 1977) and Isabela (Montoriol-Pous and Escola, 1978).

Later that year, in July and August 1982, the "Société de Spéléologie et de Préhistoire des Pyrénées Occidentales (SSPPO)" embarked on an expedition, "Ecuador 82," in which caves were catalogued in continental Ecuador as well as on the Galapagos Islands (SSPPO, 1982). This is the first general catalog of caves of the Galapagos Islands. It mentions a total of 38 cavities.

By 1985, Doctors Stewart and Jarmila Peck from Carleton University (Canada) initiated, in

6th International Symposium on Vulcanospeleology

Island	Cave		Length (m)	Biol. Work	Geol. Work	References
	Main name	Other names				
Santiago (3)	Cueva Bucanero I	Pozo de la Bahía de los Bucaneros I	567	No	Yes	27
	Cueva Bucanero II	Gruta de la Bahía de los Bucaneros II	?	No	Yes	27
	Cueva del Cráter de Sal		~ 350	Yes	Yes	27, (*)
Isabela (5)	Cueva de Sucre		355	Yes	Yes	14,16,27, (*)
	Cueva de Macas		92	Yes	Yes	14,16,27, (*)
	Cueva de La Cadena		114	Yes	Yes	14,16,27, (*)
	Simas de Las Torres		-46	No	Yes	(*)
	Simas de Cerro Grande		-20	No	Yes	(*)
Floreana (5)	Cueva de Post-Office Superior		38	Yes	No	12,16,27, (*)
	Cueva de Post-Office Inferior	G.32	202	Yes	Yes	12,16,27, (*)
	Cueva del Pinzón	Finch Cave	110	Yes	Yes	26, (*)
	Cueva de La Lechuza	Barn Owl Cave	60	Yes	Yes	26, (*)
	Cavidades de la Bahía de las Cuevas	Cueva de Los Piratas	16;10;4	No	Yes	12,27
Santa Cruz (35)	Cueva de Andrés		205	No	Yes	16,25,27
	Cueva de Iguana	G. de la Est. Darwin	100(-12)	Yes	Yes	16,25,27
	Cueva de Raúl Aguirre		115	No	Yes	13,16,27
	Cueva de Gallardo	Cuevas de Bellavista n°1 & n°2. Los Túneles	2,250	Yes	Yes	1,13,16,27, (*)
	Cueva de Sra. Colombia	C. de Jorge Sevilla	47	Yes	Yes	16,27
	Cueva de Gilberto Moncayo		590	Yes	Yes	16,27, (*)
	Cueva de Kübler	G.12	852	Yes	Yes	1,4,13,16,27,28
	Grieta del Pozo de Puerto Ayora		50(-15)	Yes	No	16
	Grietas de Bahía Tortuga		30(-10)	Yes	No	9,16,27
	Grietas en el camion por Bahía Tortuga		12(-10)	Yes	No	16,27
	Grieta de Lentenech		28(-5)	No	Yes	13,16,27
	Cuevas de la Finca Kastdalen	Cueva de Tres Pisos	1,500+500	Yes	Yes	16, (*)
	Cueva de La Curva		80	No	No	16
	Cuevita de Las Cyatheas		18	Yes	No	16
	Cueva de Huesos		750	Yes	Yes	16
	Cuevas de Fincas Vargas		20	Yes	No	16
	Cuevas de la Finca Devine		~ 100	No	No	16,23, (*)
	Cueva de La Miconia		276	No	Yes	(*)
	Cueva de Elena		677	Yes	Yes	(*)
	Sima de La Pirámide		-44	No	Yes	(*)
	Cueva 2 km al S de El Chato		500	Yes	No	16
	Cueva de Tres Entradas		400	Yes	No	16
	Cuevas de Cerro Banderas		1,000	Yes	No	16
	Cuevitas al SW de Cerro Banderas		15	Yes	No	16
	Sima del Pozo de Los Gemelos		-64	Yes	Yes	16, (*)
	Cueva sin nombre		~ 60	No	No	16, (*)
	Cueva del Cascajo		3,010	Yes	Yes	(*)
	Cueva del Monte Cascajo		~ 100	No	No	25,27
	Grieta de la Punta de Las Palmas		-12	Yes	No	22,27,29

Island	Cave		Length (m)	Biol. Work	Geol. Work	References
	Main name	Other names				
Santa Cruz (cont)	4 cavidades en Zona Naranja		?	No	No	1,25,27
	Cueva al N de El Chato		?	No	No	25
	Cueva del Caballo	C. de Cheval: G.36	?	Yes	No	8,27
	Cueva de Rovalino	Cueva de Castro	50	No	Yes	27
	Agujeros de Agua	G.26	?	Yes	No	9,27
	Cueva de Miguel Arias		~ 1,000	No	Yes	(**)
San Cristóbal (2)	Pozos de Hundimiento		-15	No	No	1,3,27
	Cueva de Cerro Pelado		?	No	No	(#)

Table I—All volcanic caves currently known on the Galapagos Islands: Spanish names are used, as caves are known by inhabitants of the islands. (*) Caves visited by us during the expeditions of 1990 and 1991. (**) Pat Whelam personal communication (#) Oral communications from SPNG on San Cristóbal.

collaboration with the Charles Darwin Research Station, a project, still being carried out, for the study of the biology and distribution of the cave-dwelling and soil anthropods of the Galapagos.

In 1986 the initial results of their studies were published (Peck and Peck, 1986a) in which 30 cavities were cited and in which interesting information was given about cave locations, biological characteristics of certain caves, and unpublished maps drawn by Chris Vanbeveren in 1985. In 1986 the American paleontologist, David Steadman, published a study on vertebrate fossils of the island of Floreana (Steadman, 1986), in which he shows maps of various caves on this island. His studies on vertebrate fossils found in the interior of the lava tubes have permitted him to discover unknown caves which are cited in his paleontological studies (Steadman, 1981, 1982; Steadman and Ray, 1982).

Biospeleology

The first biological study of the subterranean fauna of these islands was carried out by N. and J. Leleup of the Belgian Royal Museum of Central Africa, who in 1965 spent six months on the Galapagos Islands, collecting and studying cryptozoic wildlife. These authors found ten species in underground waters, in cracks of rocks, in the soil, and in caves (Leleup, 1967, 1968). Among the interesting finds made by these Belgian scientists on the expedition was an eyeless fish *Caecogilbia galpagoensis* Poll and Leleup, as well as several albino crustaceans (Van Mol, 1967; Poll, 1976). The samples taken by Leleup came from only three caves, and this suggested indirectly that

there existed a terrestrial troglobite fauna on the islands. Leleup thought this wildlife to be a relict fauna from immigrants of the Pleistocene period (Leleup, 1976).

The presence of this fauna has not only been confirmed but has been considerably increased thanks to the recent work by S. and J. Peck (Peck and Peck, 1986b, 1986c; Peck and Shear, 1987a, 1987b; Campbell and Peck, 1989). According to the latter authors, the total number of species of cryptozoic anthropods comes to 56, of which 21 (37.5%) have been found inside caves (Peck, 1990).

Results

According to the specialized literature that has been consulted, as well as our own field research, the total number of volcanic caves currently known on the Galapagos Islands is 50. Their distribution on the various islands is quite diversified, which reflects—besides the speleological richness itself of each island—more importantly, the different degree to which each one of them has been studied. In this way, the island of Santa Cruz, perhaps that which has had the most human activity, shows a total of 35 cavities, Floreana 5, Isabela 5, Santiago 3, and San Cristobal 2 (Table I).

Most of these caves are horizontal lava tubes (although many of them have an abundance of vertical extensions in their interior, which form passages to other tubes located at different levels). The rest are vertical pits, formed sometimes by the reflux of lava in the interior of volcanic chimneys, and other times by the fracturing of the earth as a consequence of seismic movement.

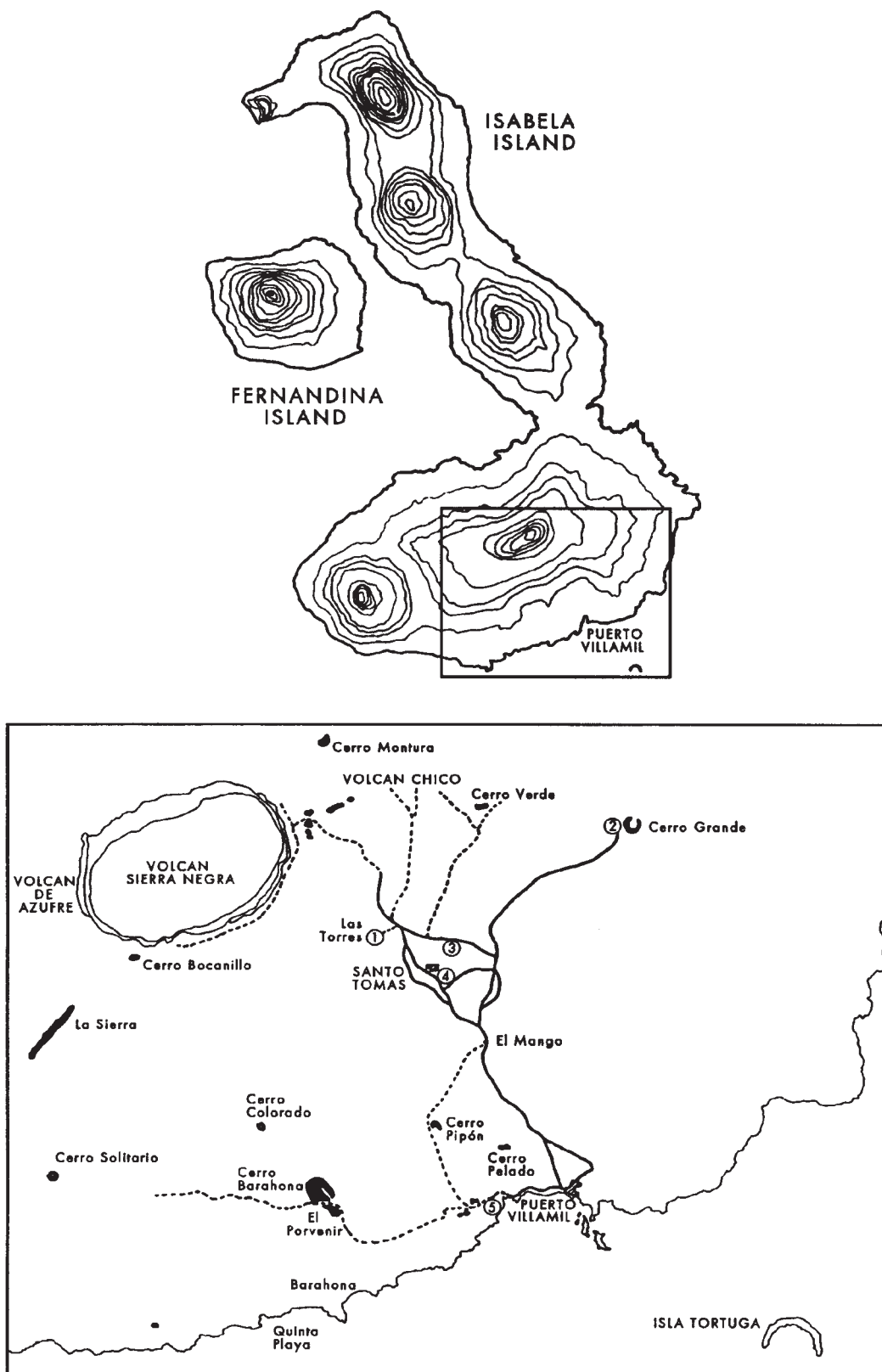


Figure 2— Location of known caves on Isabela Island. 1=Pits of Las Torres. 2=Pits of Cerro Grande. 3=Macas Cave. 4=Sucre Cave. 5=La Cadena Cave.

The field study carried out during the expeditions of 1990 and 1991 has led to the location and mapping of six previously unknown caves (Pits of La Piramide, Cerro Grande and Las Torres and the Elena, Miconia and Cascajo Caves) in addition to two caves previously mentioned in other writings but which had never been mapped (Pit of Pozo de Los Gemelos and Kastdalen Cave).

The following pages describe these eight findings with information about the location, access, related fauna, and state of preservation of each one.

1. Isabela Island (Figure 2)

There were only three small caves whose existence was known on this large island. The contacts established in Puerto Villamil with Sr. Arnaldo Tupiza, the current representative of the Galapagos National Park Service on Isabela (SPNG), has

allowed us to locate two groups of pits that were until then unexplored (Figure 2).

1.a. Pits of Cerro Grande (Figure 3)

Unlike the Las Torres pits, the pits of Cerro Grande are part of a large crack or fracture in the ground, caused by seismic movement. They are located near the Cerro Grande, to the northeast of Santo Tomas (Figure 2). The largest of these pits do not exceed 20 meters in depth and, similar to the next case, their narrowness makes them extremely difficult to explore.

1.b. Pits of Las Torres (Figure 4).

This is a group of small pits that have a maximum depth of 46 meters and a minimum depth of 25 meters. They start at the emission tubes of small eruption vents, known as Las Torres and are lo-

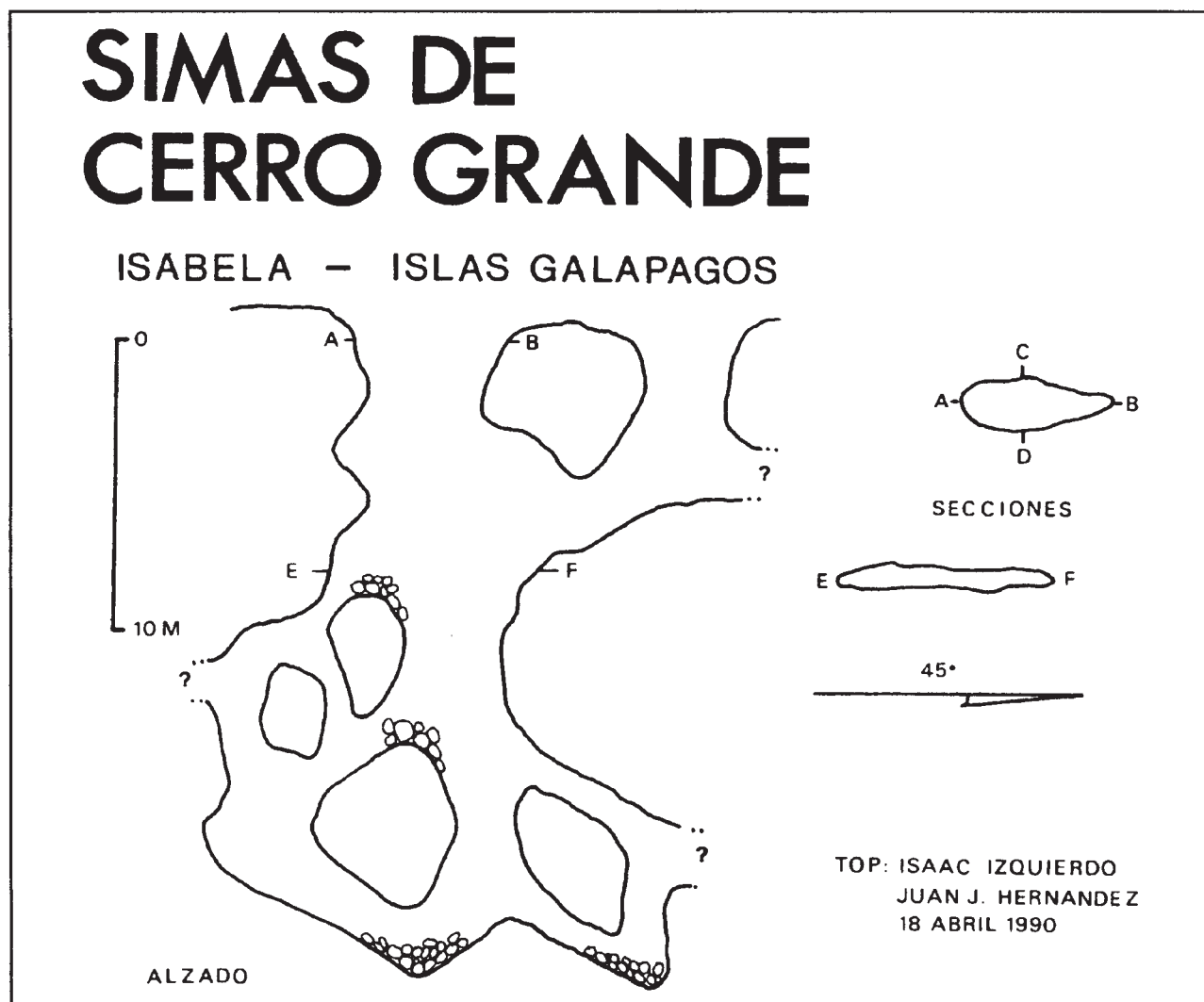


Figure 3—Pits of "Cerro Grande."

SIMAS DE LAS TORRES

ISABELA -- ISLAS GALAPAGOS

TOP: ISAAC IZQUIERDO
JUAN J. HERNANDEZ
16 ABRIL 1990

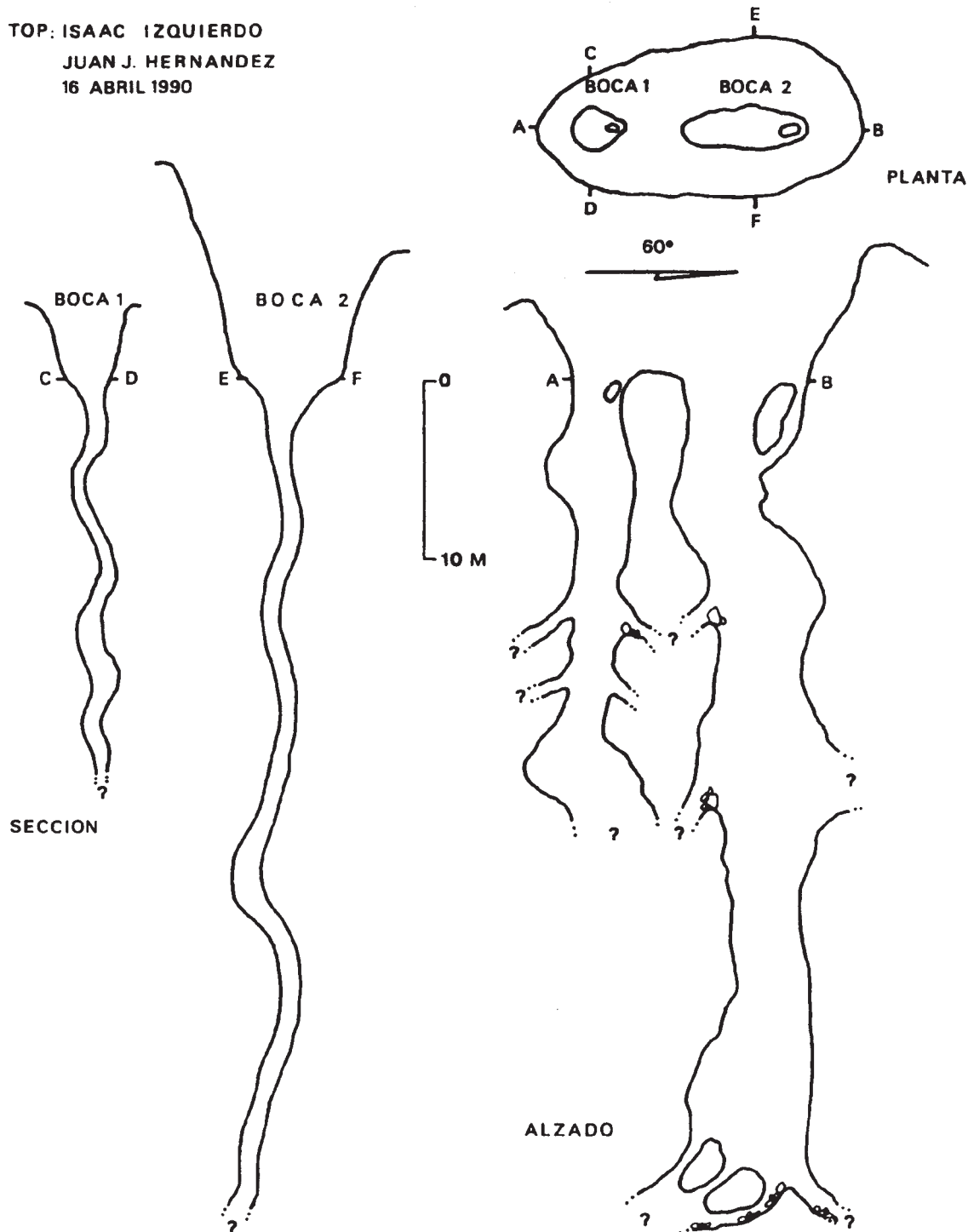


Figure 4—Pits of “Las Torres.”

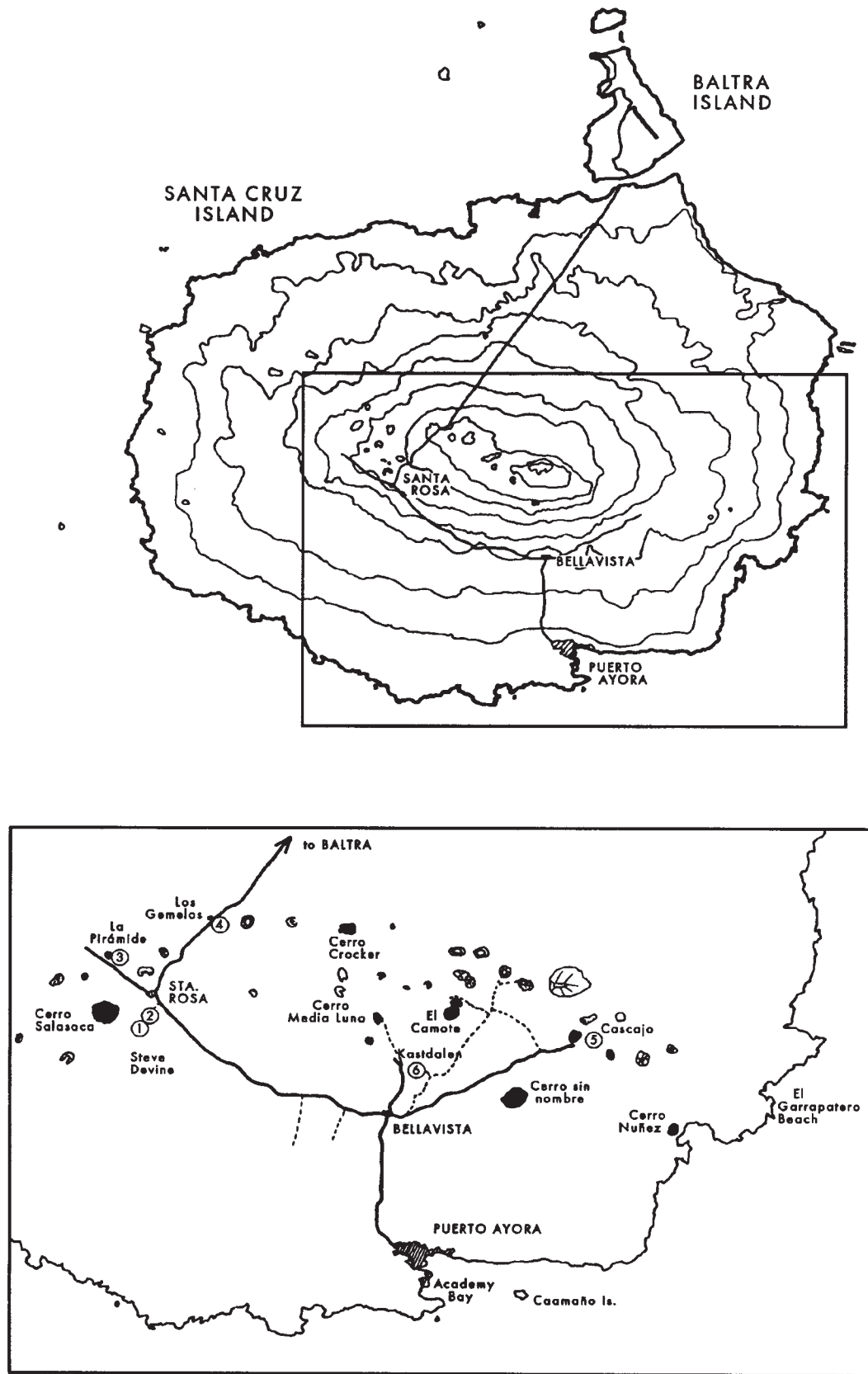


Figure 5—Location of caves mapped by us on Santa Cruz Island.

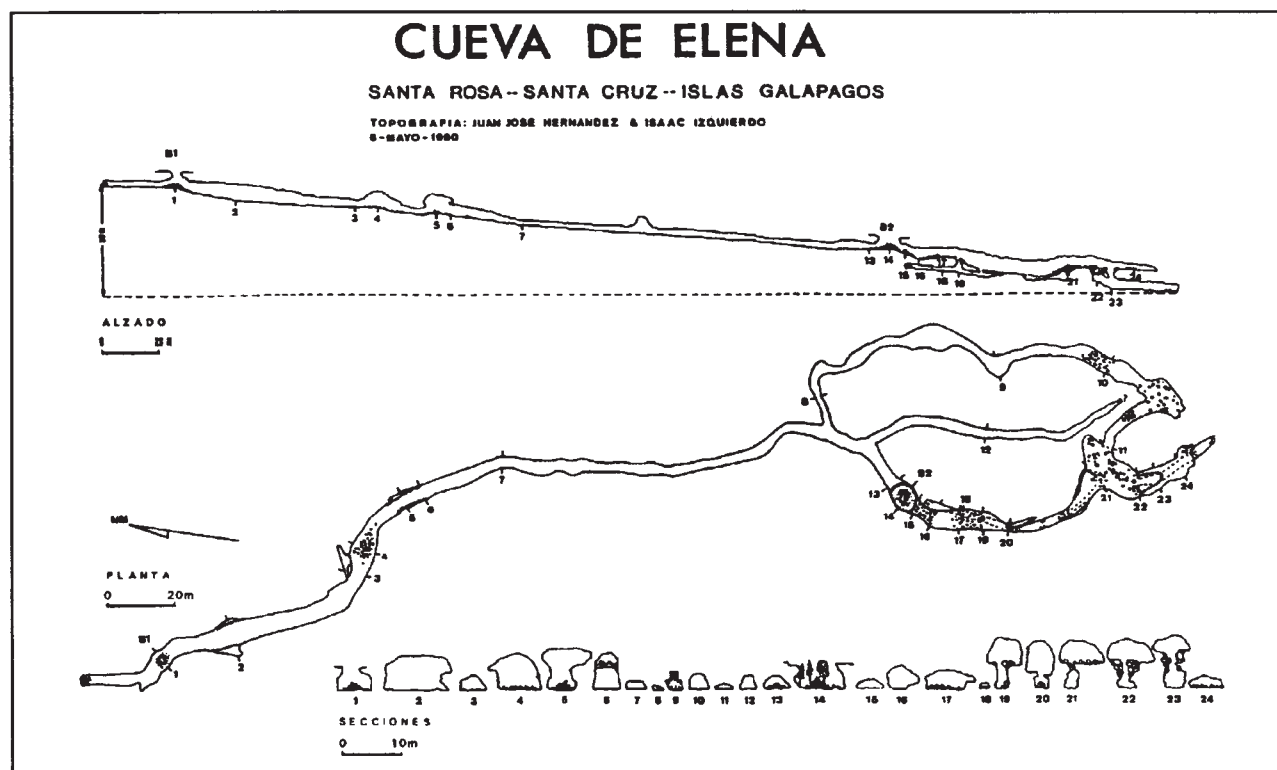


Figure 6—Elena Cave.

cated between the agricultural area of Santo Tomas and the south side of the Sierra Negra Volcano. There are extremely narrow passages that extend between the two pits. Generally these pits are in the form of long, narrow cracks, with an average width of one meter. Entering these caves is not only difficult because of their narrowness but also quite dangerous due to the constant threat of rock slides. There exists a large number of bone remains, especially of galapagos (*Geochelone*), which have fallen inside.

2. Santa Cruz Island (Figure 5)

2.a. Elena Cave (Figure 6)

Located on the property of Steve Devine, in the agricultural area of Santa Rosa, Elena Cave is 677 meters in length, with two accesses for which a small climb is required to enter. This cave displays a curious form of geomorphology, a type of labyrinth in its lower extreme. The difference between the upper and lower part of its slope is around 38 meters and some of the larger passages reach heights of up to 10 meters. It also exhibits some lava stalactite formations as well as small overlapping tubes.

Inside the cave the temperature is around 23.6° Celsius and the relative humidity is high (90 to 95%). The fauna which have been collected, and are still being studied, seems to be quite interesting. In the interior of the passageways lives the only species of Galapagos troglitic rove beetle (*Pinostygus galapagoensis* Campbell and Peck); an undetermined pseudoscorpion associated with decomposing roots, spiders (Pholcidae and Linyphidae), millipedes (diplopods Polydesmidae), the amblipigy *Charinus insularis* Banks, depigmented woodlice, the blind earwig *Anophthalmolabis* sp., and so on.

The cave receives virtually no visitors and it is in an excellent state of preservation.

2.b. La Miconia Cave (Figure 7)

This small tube, 276 meters in length, is also located on the land of Steve Devine, not far from the previously mentioned cave. This cave displays a uniform, linear arrangement, with two entrances, one at the upper extreme and the other in the middle, where the cave becomes quite narrow. The difference between each end of the slope is 24 meters. This cavity is apparently of little biological interest.

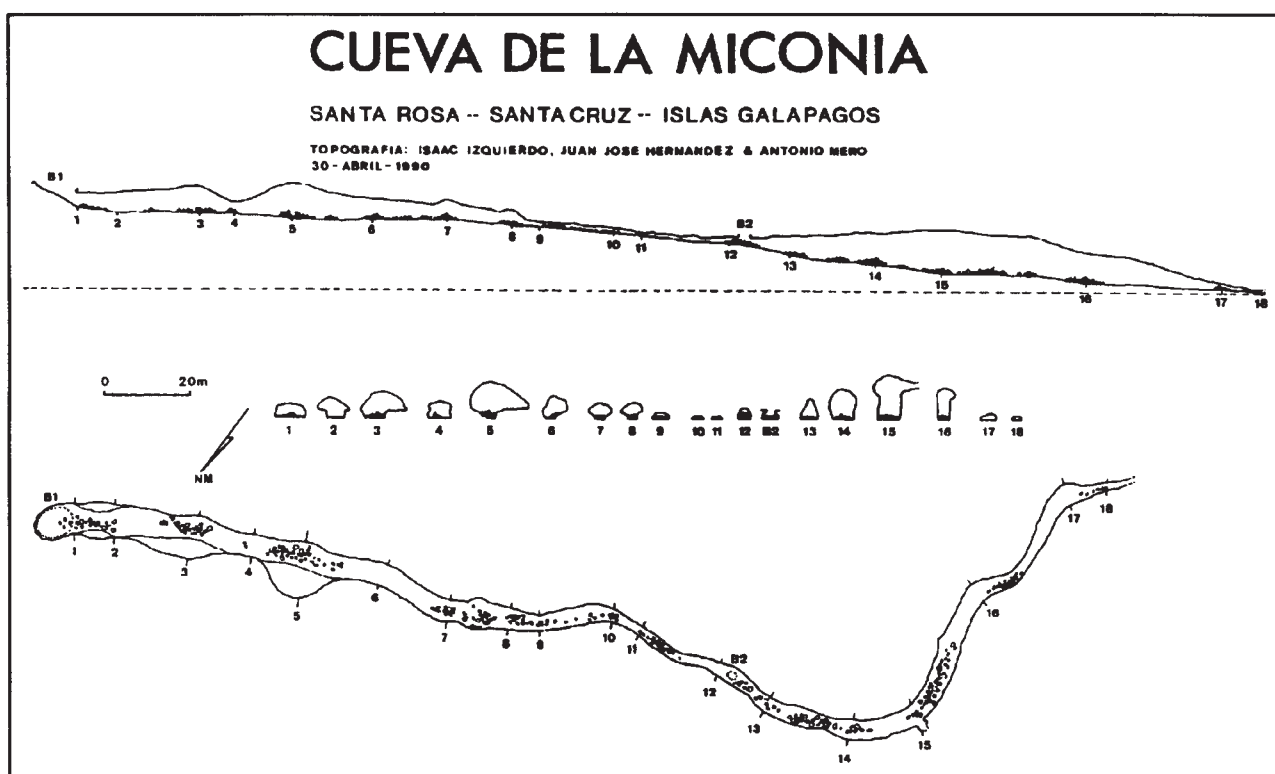


Figure 7—“La Miconia” Cave.

2.c. Pit of La Piramide (Figure 8)

This pit, also located in Santa Rosa (Salasaca), is an emission tube located at the very center of the crater of “La Pirámide” giving it a curious geomorphology. This pit features a hollow pyramid-like monolith which projects out of the ground, making almost 11 meters of its 44 meters of total depth surficial. Below the ground level the pit drops to 33 meters shooting off in three directions into large openings. Bone remains of giant rice rats can be found in the deepest opening, but it appears that the cave does not offer anything of much interest in the way of fauna. Given its difficult access, the cave is not visited and its good state of preservation has been maintained.

2.d. Pit of Pozo de Los Gemelos (Figure 9)

The Pozo de Los Gemelos is a well-known place on Santa Cruz Island and one of the important tourist attractions. It consists of large sunken calderas located on both sides of the road that goes from Puerto Ayora to Baltra, approximately 2.5 kilometers northeast of the Santa Rosa crossing. Between these two large calderas, some ten meters from the southwest corner of the one furthest to

the east, there is a well or pit with an almost circular mouth of some ten meters in diameter. This diameter is reduced to form an almost cylindrical chimney of some two to three meters in diameter, widening again at its lowest height and bifurcating into two opposite openings. Although this cave is found just between two large collapses in the area, it does not seem to have originated in this way. The walls along the chimney, and in the two lower openings, have a perfectly visible lava layer, which makes one suppose that this acted as an exhaust tube for molten lava material. According to our information, we were the first to explore this pit.

The cave is about 560 meters above sea level and its total depth is 64 meters, with a vertical drop from its mouth of 52 meters. The exterior temperature was 32.3° Celsius, while at the deepest end of the pit it falls as low as 29° Celsius.

From a biological point of view, there were several surprising discoveries: eyeless harvestmen (currently being studied), small depigmented polydesmid diplopods, symphyla, springtails, two-pronged bristle tails, and ants. Crane flies were especially abundant at the lower end.

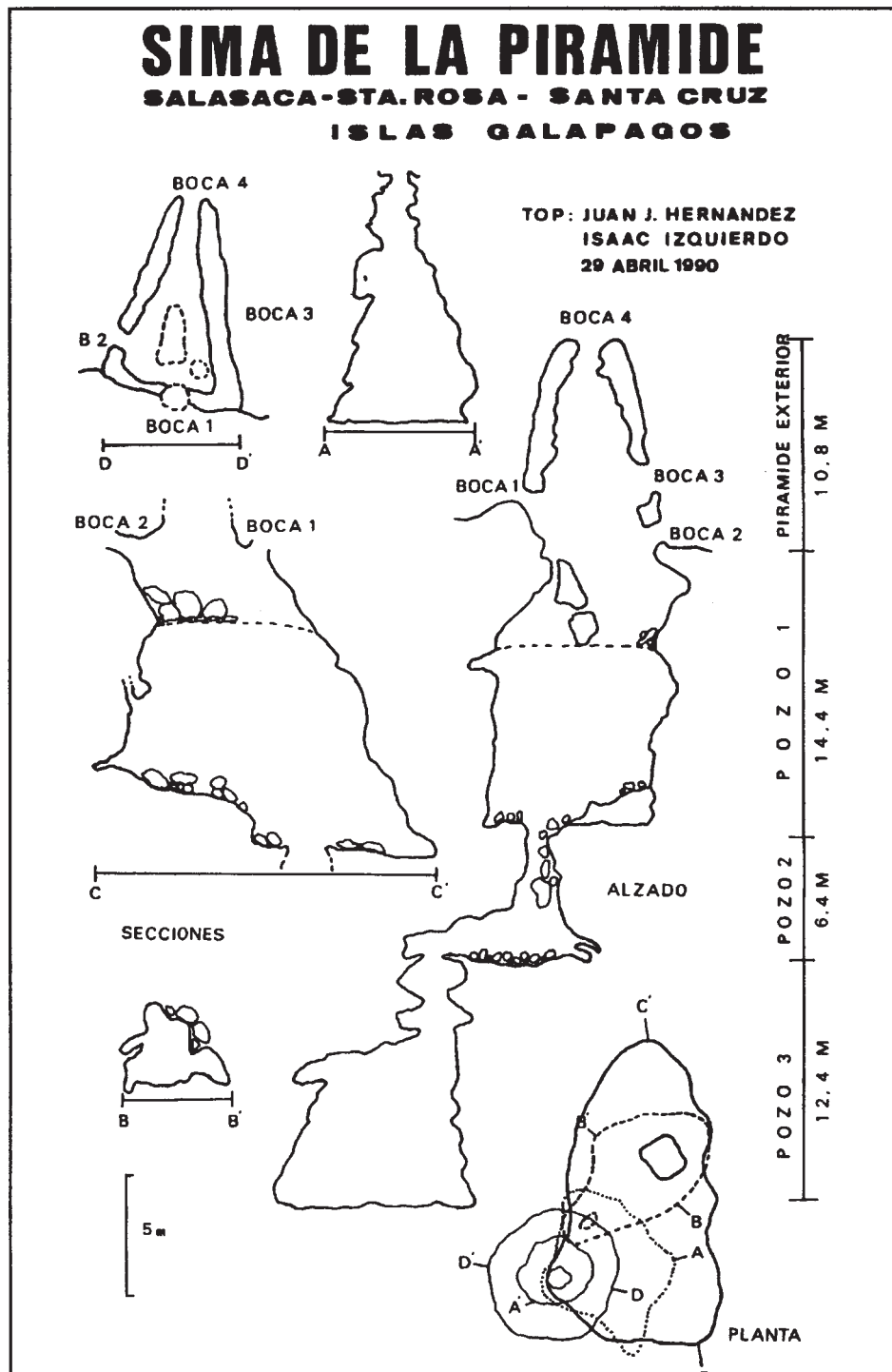


Figure 8—Pit of "La Piramide."

Even though it is located in the Galapagos National Park, the numerous tourists that visit the mouth of the pit occasionally throw in stones. These stones have accumulated to the point that the original floor of the cave is almost no longer visible.

2.e. Cascajo Cave (Figure 10)

This is a large cave located some 700 meters (15 minutes on foot) east of Mount Cascajo, about eight kilometers from Bellavista. In the rainy season, the area around the access to the cave is usually flooded, forming large overflowing pool which makes it difficult to enter. However, a detour from the foot trail which goes to El Garapatero beach from Mount Cascajo could be an alternate route. Since this interesting cave is practically unknown to most of the inhabitants of Santa Cruz, we show in Figure 11 one of the accesses to the cave (to entrance number 5 at 230 meters altitude), where Wilfrid Urive from Bellavista guided us. He is a good contact to find the cave.

From a speleometric point of view this is without a doubt the most important volcanic cave of the Galapagos Islands. Its 3,010 meters of length makes it the longest known lava tube of all these islands (and perhaps in all of South America). It is a large lava tube with a uniform, linear arrangement, there are practically no lateral ramifications and in some areas there are

up to four overlapping tubes, all oriented in the same direction. Along its 2,007-meter length from one end to the other, there are 14 skylights. At some points in the cave there are unlevel areas in the form of lava cascades (the maximum being seven meters), making it necessary to use rope to get over

SIMA DEL POZO DE LOS GEMELOS

SANTA CRUZ
ISLAS GALAPAGOS

TOP.: I. IZQUIERDO; J. J. HERNANDEZ & P. OROMI
(ABRIL 1991)

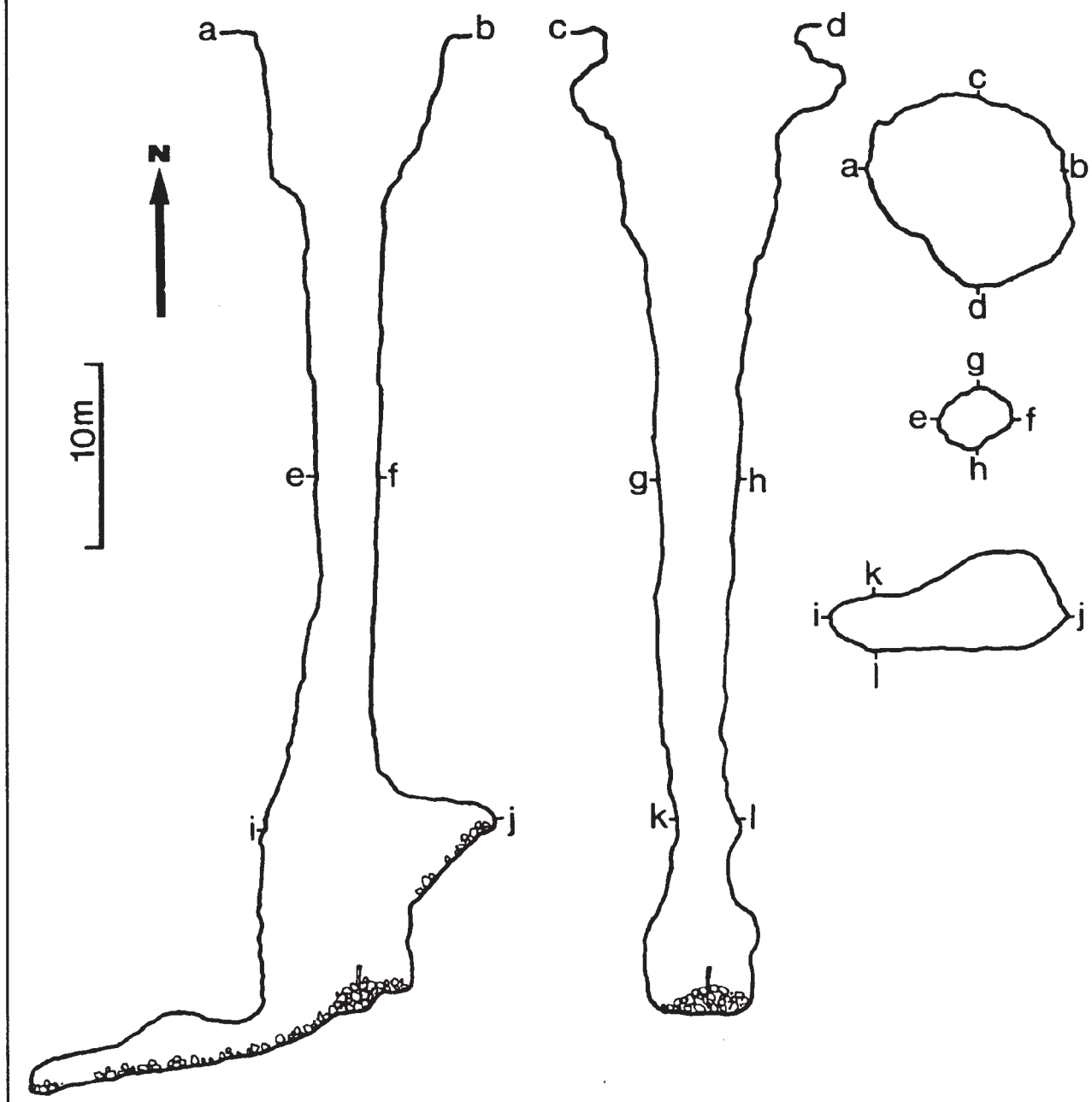


Figure 9—Pit of “Pozo de Los Gemelos.”

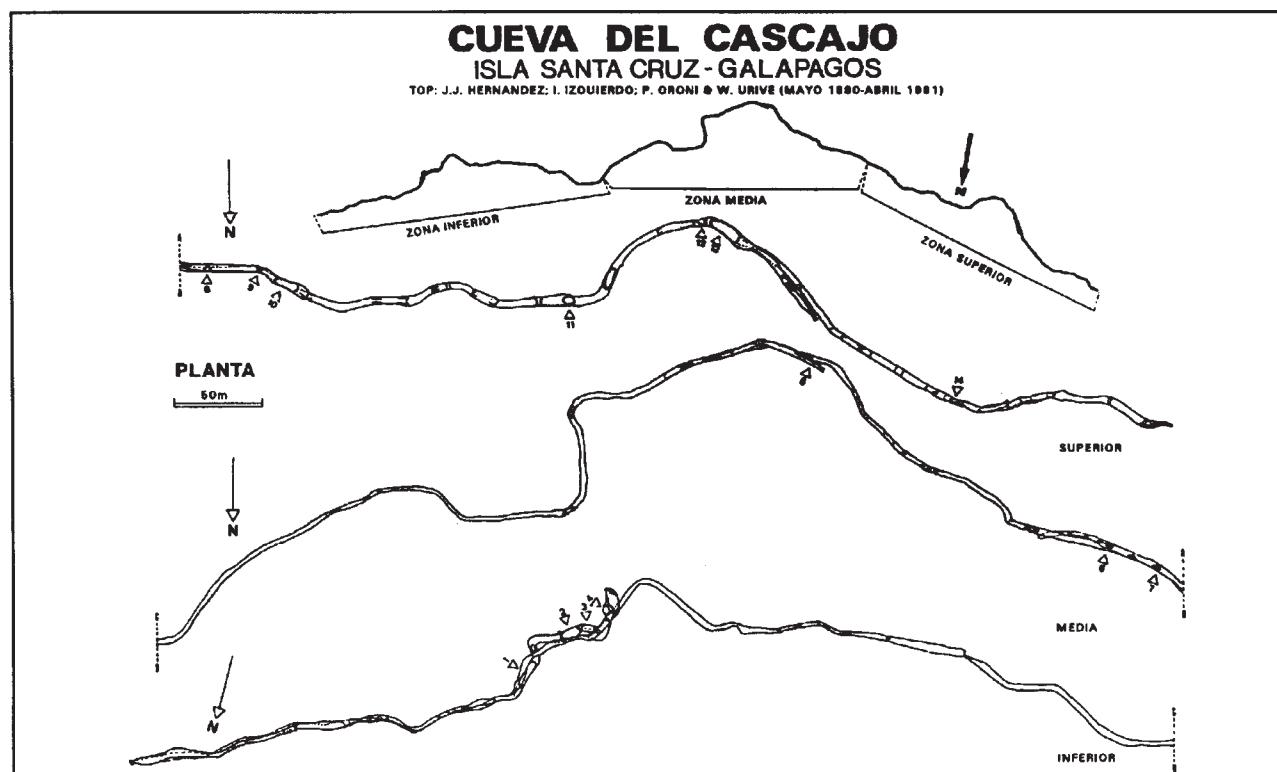


Figure 10—Cascajo Cave. Ground plan.

them. In many of these skylights it is not unusual to see a Galapagos Barn Owl (*Tyto alba*) nesting. The large quantity of bone remains of the extinct Giant Rat of Santa Cruz (*Megaoryzomys curioi*) is surprising, and there are also remains of land iguanas, galapagos, and various types of birds. In this way, Cascajo Cave represents an important paleontological deposit which should be studied.

The invertebrate fauna is unquestionably rich and varied. In the first sampling the presence of spiders (Pholcidae and Linyphidae) was detected, along with the amblypygid *Charinus insularis*, depigmented millipedes (diplopods Polydesmidae), centipedes, Symphyla, depigmented woodlice, springtails, cockroaches, two-pronged bristle tails (Diplura, campodeids), ground beetles (*Calosoma*), tenebrionids and curculionids beetles,

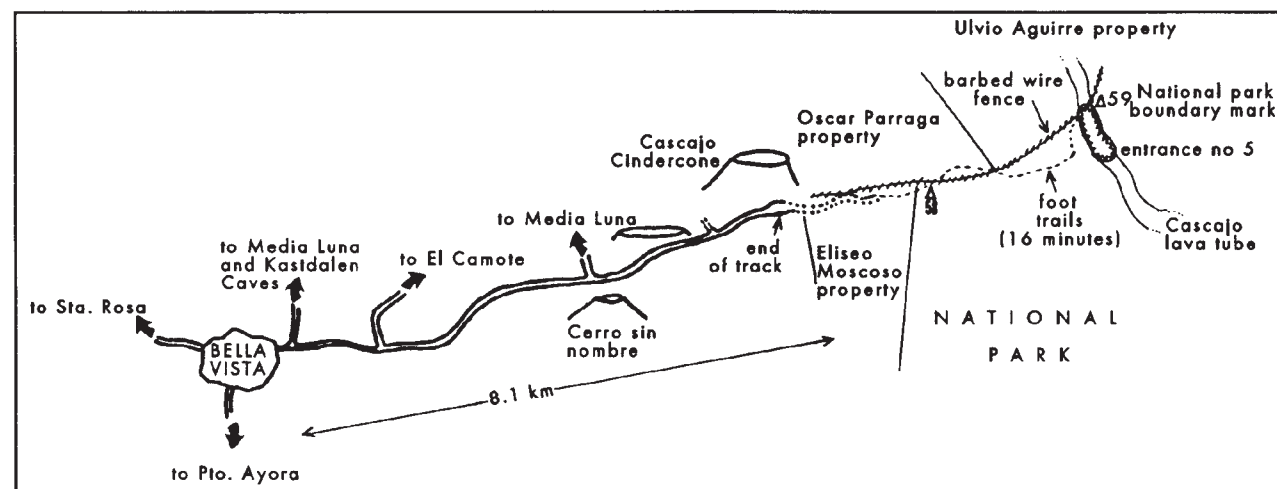


Figure 11—Location of Cascajo Cave and a way of access to the cave's entrance No 5.

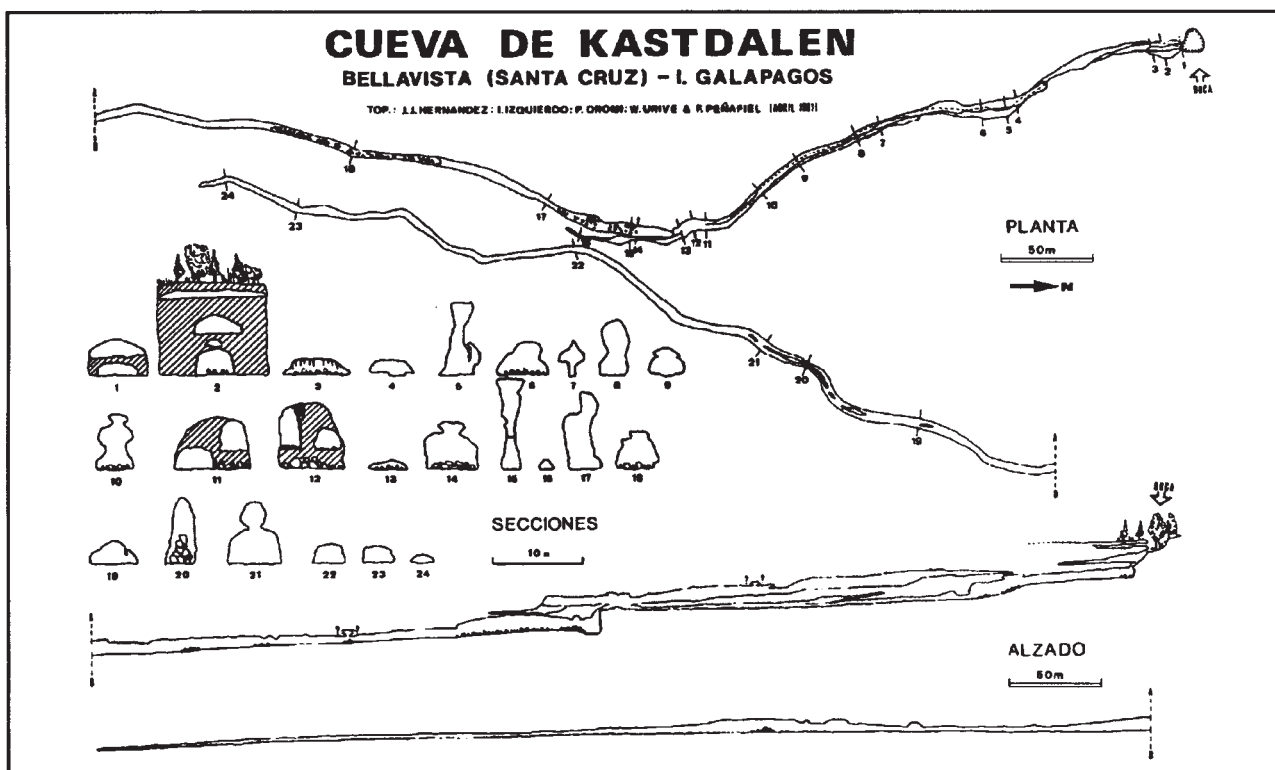


Figure 12—Kastdalen Cave.

lepidopteras, dipteras (Phoridae, Sciaridae, and Tipulidae), ants, and so on. Of special interest is the discovery of a new species of a troglobite curculionid beetle, belonging to the genus *Anchonus*.

Due to its great length this cave extends under private land and also into areas of the National Park. It receives practically no visitors and it is not unusual to find at its entrances the remains of livestock (mostly cows) which have fallen in.

2.f. Kastdalen Cave (Figure 12).

This cave is located on Kastdalen Farm, some two kilometers northeast of Bellavista at an altitude of approximately 300 meters above sea level. As it is well described in Peck and Peck (1986a), it consists of a series of four entrances to sections of the large lava tube. These sections do not communicate underground and, although they haven't been mapped, they are estimated to have a total length of some 500 meters (Peck and Peck, 1986a). Our work was centered on the entrance at the southeast end, which gives access to three overlapping tubes of which the lowest one has yet to be studied, due to the difficulty presented by its verti-

cal access. Its entrance looks exactly like what it is, a large lava tube, measuring 1,500 meters long.

Although Kastdalen Cave extends towards the big Cave of Bellavista, it does not connect with it. The part of the cave that is perhaps the most interesting has a vertical fall of some 12 meters which makes it necessary to use a rope for its exploration. The last section, which is very easy to move through, features white mineral deposits of simple composition, covering the ceilings, walls, and floors. This tube had already been explored by Chris Vanbeveren in 1985, but given its difficult access, it remains practically undamaged.

These lava tubes have unquestionable biological interest. Peck and Peck (1986a) had already found, in the curved sections of the northwest sector, an interesting troglobitic fauna made up of harvestmen, *Galanomma microphthalmum* Juberthie, and pholcid spiders (*Corysocnemis* spp.) among others. Our samplings topped off these finds with the presence of slugs, eyeless spiders (Gnaphosidae), woodlice, the silverfish *Nicoletia meenerti* Silvestri, earwigs, ants, click beetles, and so on.

Speleology In The Galapagos

The volcanic caves on the Galapagos Islands are truly a natural heritage. Their special geomorphology is of great geological interest because through them the constitution and dynamics of their interior formation can be studied. Biologically, they are of even greater interest since inside of them live very special animal communities, in which many of the species are totally dependent on the environmental conditions of the subterranean ecosystem.

Sometimes these cavities can also represent important paleontological deposits since the remains of animals which no longer exist have been preserved in their interior for thousands of years. In many cases we only have these bone remains to lead us to the knowledge of their existence.

The peculiar cryptic fauna that live in these caves, and in general the entire network of subterranean spaces, is extremely interesting from an evolutionary point of view, given the simplicity of the ecosystems in which they develop. There is no doubt that this is just the beginning of the study of the cryptozoic animals on the Galapagos, and judging from the finds that have been made in the lava tubes of the Azores, Canary, and Hawaiian Islands (Oromí *et al.*, 1990; Hernandez *et al.*, 1986; Martín *et al.*, 1989; Howarth, 1972, 1982) there are still many cryptic species which have yet to be discovered on those islands, although the role of these species is already starting to become understood in the functional dynamics of island ecosystems.

We are fortunate to be able to say that today the Galapagos caves are in an excellent state of preservation. In some cases the steepness of the entrances to the caves is what has stopped visitors from coming and therefore an optimum state of preservation has been maintained. In other cases this has been simply due to ignorance of their existence. Nevertheless, the population of the Galapagos is growing sharply, and the number of tourist-visitors is progressively increasing each year.

All this has already meant more interest on the part of the colonists who live in the agricultural area of Santa Cruz to use the lava tubes that exist on their land for tourist purposes. With an infrastructure that leaves much to be desired, part of the Bellavista Cave is being utilized for this purpose under the name "The Tunnels." Other land-owners are beginning to request reports on the tourism viability of the caves. In some cases these caves have tremendous biological and paleontolog-

ical interest and, though they are not located within the limits of the Galapagos National Park, they should be preserved at all cost. We therefore urge that these natural resources located on the Galapagos Islands be completely catalogued, in order to carefully organize their use (tourist/didactic and scientific) and that the appropriate organizations plan the territory properly, considering the natural value that these caves represent.

Acknowledgements

The authors wish to thank Dr. Stewart Peck (Carleton University, Canada) for the valuable information he made available about the mapping and location of many of the caves. We would also like to thank the Charles Darwin Research Station, and especially Pat Whelan, Fionnuala Walsh, and Sandra Abedrabbo for their invaluable collaboration during our stay on the Galapagos. The Galapagos National Park Service for the authorization granted to us, and especially Sr. Arnaldo Tupiza for his great assistance in the work on Isabela Island. To P.N. Ashmole and N. Ashmole for their collaboration in the field work. To our good friend, guide, and collaborator Wilfrido Urive and the kind staff of the Hotel Galapagos for their hospitality and those unforgettable good times we shared with them.

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