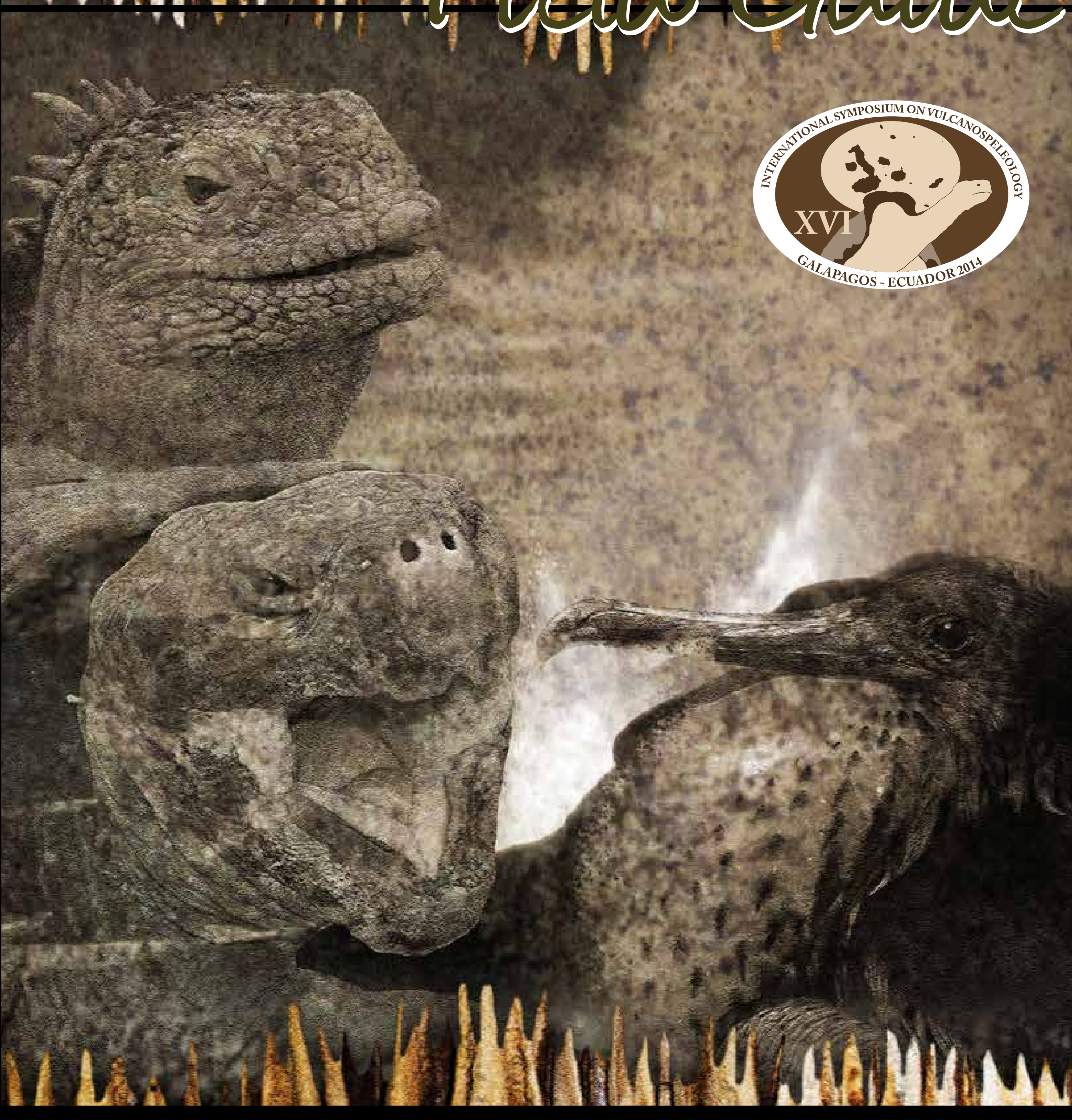
Abstract Volume & Field Guide



16th International Symposium of Volcanospeleology
2do Simposio Internacional de Espeleología

Ecuador - Galapágos

Dear All,

A very warm welcome from Ecuador, now let us tell you a bit about a magic place called Galapagos!!!!

The Galapagos Islands in the same way like Hawaii, have been generated by a hot spot and are therefore volcanic in origin. We have had various expeditions to the islands in recent years, most of them with experiences US cavers leaded by Aaron Addison from Washington University in St. Louis Missouri, besides Theofilos Toulkeridis Ecuadorian teams. The recent findings are spectacular including not only easy accessible lava tubes but also inner parts of volcanoes, one with an inner depth of 101m, besides others. The up to now not published, results are also nothing less than volcanic, entomological and paleontological (among other research) spectacular. All these beauties are expecting you!

About Galapagos, besides geology, there is no need to talk much about. It´s amazing, it´s extraordinary, it´s unique. Swimming with sharks, dolphins, manta rays, playing with sea lions or sea turtles or having contact with hawks and blue footed boobies at a few inches away can be an everyday activity!

For activities like the 16th IVS, we would fly from the continent with commercial planes (TAME, LAN or AEROGAL) from Quito or Guayaquil. A flight to Ecuador is certainly cheaper from the US or Europe than towards Chile or Hawaii. The overnight costs are also much cheaper than people may even dream of, as we are not taking any luxurious cruise.

The former chancellor of the Universidad de las Fuerzas Armadas ESPE close to Quito, General Carlos Rodriguez has been the witness of honor in the foundation of the Ecuadorian Scientific Speleological Society (ECUCAVE) and an amateur caver as well as a big fan of research activities in the Galapagos. The new and actual chancellor General Roque Moreiro gave his blessings to our research and wished us success in realizing this magnificent event in the islands and the continental mainland.

See you all in Quito, Ecuador and Galápagos are waiting for you, yours.

INTERNATIONAL SYMPOSIUM ON VULCANOSPELEOLOGY
XVI
GALAPAGOS - ECUADOR 2014

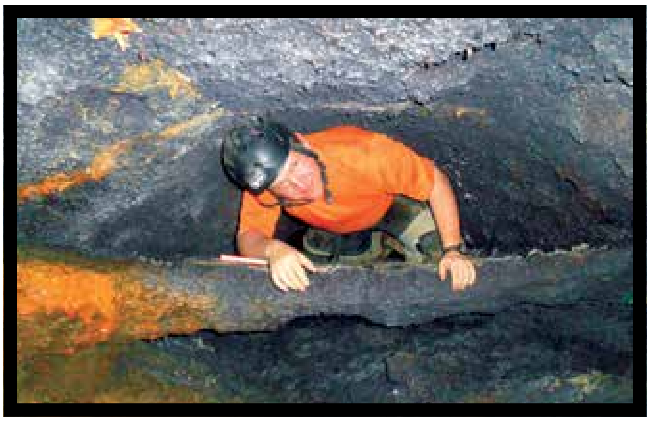
Chairmen of the 16th IVS

Theofilos Toulkeridis
Universidad de las Fuerzas Armadas ESPE Ecuador

Aaron Addison
Washington University, St. Louis, MO, USA

Looking through a collapsed lava tube in Chinese Hat island

Theofilos Toulkeridis



Smiling although it hurts crawling above a narrow aa flow base in Royal Palm cave

Theofilos Toulkeridis

Abstract Volume & Field Guide

16th International Symposium of Vulcanology
2nd Simposio Internacional de Espeleología
Galápagos, Ecuador

Main organizing and mapping team 2013: Upper left Rick Haley, Glenn Robert Osborn, Aaron Addison, Geoffrey Brian Hoese; middle: Scott Linn, Rick Toomey, Elizabeth Winkler, Antonio Gallardo (96 years old), Theofilos Toulkeridis; below: Batgirl Omura Missing: Steven Joseph Taylor, Joann Jacoby, Guinevere McDaid *Theofilos Toulkeridis*

Highland of Santa Cruz Island, location of most volcanic caves of the 16th ISV *Instituto Geográfico Militar*

DAY BY DAY

16th INTERNATIONAL SYMPOSIUM OF VOLCANOSPELEOLOGY – 2do SIMPOSIO INTERNACIONAL DE ESPELEOLOGÍA GALÁPAGOS, ECUADOR

8th to 15th of March

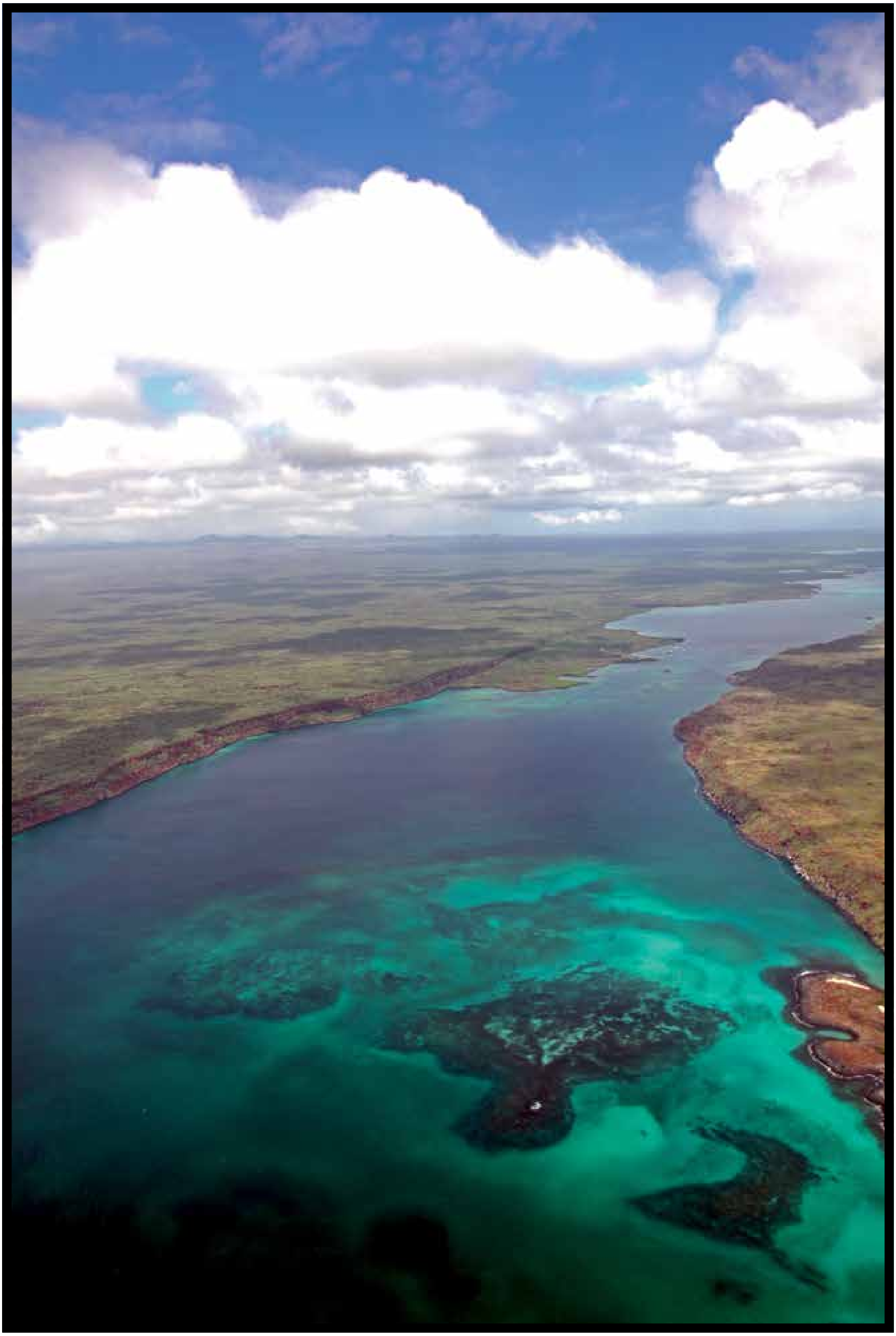
Main organizing (and mapping) team arrives at the 8th of March on the islands. For early pre-symposium activities and hotel reservation etc you had to contact Aaron Addison (cave activities) and Theo. Toulkeridis (cave and other activities).

Panoramic view of Puerto Ayora, site of the 16th ISV *Instituto Geográfico Militar*

Tortuga Bay, most beautiful beach of Ecuador in Galapagos just 40 min away by foot from Puerto Ayora *Alois Speck*

List of Participants

Cathie Plowman	**Australia**
David Butler	**Australia**
Franz Lindenmayr	**Germany**
Gregory Middleton	**Australia**
Peter Bosted	**USA**
Ann Bosted	**USA**
Stephan Friedrich Johannes Kempe	**Germany**
Michael Sutton	**USA**
Susan Hagan	**USA**
James Carl Patera	**USA**
Dave E. Bunnell	**USA**
Frank Howard Binney	**USA**
Janie Hopkins	**USA**
Linda Starr	**USA**
Robert Cornish	**USA**
Walter Olenick	**USA**
M.rae Nadler-Olenick	**USA**
Philip John Collett	**UK**
Kirsty Mills	**UK**
Martin Mills	**UK**
Luis Espinasa Closas	**Mexico**
Ramon Espinasa Closas	**Mexico**
Richard Lewis Breisch	**USA**
Robert Arland Richards	**USA**
Gunnhildur Stefánsdóttir	**Iceland**
Árni Björn Stefánsson	**Iceland**
Julia Mary James	**Australia**
Alan Thomas Warild	**Australia**
John Broughton Brush	**Australia**
Marjorie Ann Coggan	**Australia**
Harry Marinakis	**USA**
Ric William Elhard	**USA**
Sharon Joyce Herrera	**USA**
TeodoraRudolph	**Switzerland**
Paul Hermann Zehnder	**Switzerland**
Simeon Ioan Zehnder	**Switzerland**
Paige Monique Johnson	**USA**
Charles Edward Lee	**USA**
Raquel Daza Brunet	**Spain**
Tsutomu Honda	**Japan**
Stephen Smith	**USA**
Paolo Forti	**Italy**
José Maria Calaforra Chordi	**Spain**
Charles Chavdarian	**USA**
Akira Miyazaki	**Japan**
Chiharu Sato	**Japan**
Peter Bennet	**UK**
Caroline Suter	**UK**
Ben Cooper	**UK**
Timothy Francis	**UK**
Reinhold Heinrich Scherrer	**Switzerland**
Jenny Kuo	**USA**
Michael John Day	**UK**
Patrice Ann Day	**USA**
Manuel Guerrero	**Spain**
Asunción Galera	**Spain**
Michael Norman Spilde	**USA**
Penelope Jane Boston	**USA**
Steven Michael Welch	**USA**
Valrie Arriel Hildreth-Werker	**USA**
James Craig Werker	**USA**
Maximillian Hanno Wilhelm Dornseif	**Germany**
Mary Rose	**USA**
Wayne Krieger	**USA**
Kelley Prebil	**USA**
Theofilos Toulkeridis	**Ecuador**
Steven Joseph Taylor	**USA**
Joann Jacoby	**USA**
Glenn Robert Osborn	**USA**
Aaron Addison	**USA**
Geoffrey Brian Hoese	**USA**
Rick Haley	**USA**
Scott Linn	**USA**
Guinevere Mcdaid	**USA**
Rick Toomey	**USA**
Elizabeth Winkler	**USA**
Nils Suhr	**Germany**
Yamirka Rojas Agramonte	**Germany**
Jorge Mahauad	**Ecuador**
Iván Carmigniani	**Ecuador**
Arturo Izurieta	**Ecuador**
Edinson Cárdenas	**Ecuador**
Oscar Carvajal	**Ecuador**
Ricardo Visaira	**Ecuador**
Johannes Ramirez	**Ecuador**
Jorge Carrión	**Ecuador**
Pedro Ramón	**Ecuador**
Xavier Jaramillo	**Ecuador**
Rafael Díaz	**Ecuador**
Oscar Chica	**Ecuador**
Marco Paz	**Ecuador**
Ingrid Jaramillo	**Ecuador**
Francisco Moreno	**Ecuador**
Paola Buitrón	**Ecuador**
Santiago Naranjo	**Ecuador**
Mónica Alvear	**Ecuador**
Mónica Soria	**Ecuador**
Diogenes Aguirre	**Ecuador**
Livia Gallardo	**Ecuador**
Antonio Gallardo	**Ecuador**
David Árias	**Ecuador**
Ulysses Alvarado	**Ecuador**
Johanna Moreno	**Ecuador**
Klever Villacis	**Ecuador**
Galo Quezada	**Ecuador**
Grace Loza	**Ecuador**
Brigida Villacis	**Ecuador**



Aerial view of the Itabaca Channel separating Baltra island from santa Cruz Island *Alois Speck*

CASCAJO CAVE

Ann Bosted in a multi-level tube cave site of Cascajo cave, part of the pre-symposium caving activities. *Peter & Ann Bosted*

BobOsburn *Aaron Addison*

Rick Haleyand Scott Linn *Aaron Addison*

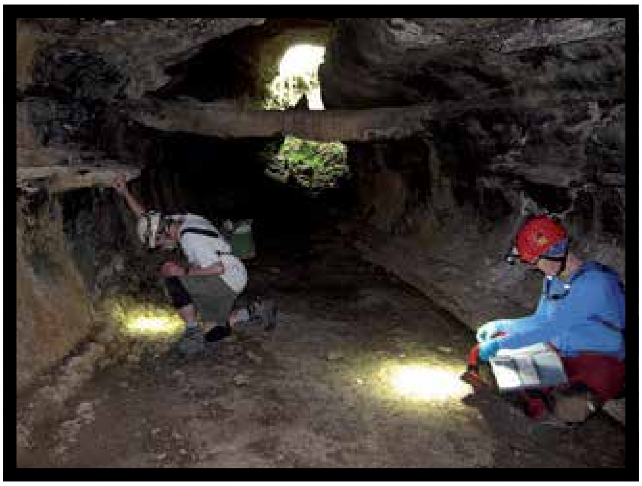
CASCAJO CAVE

Franz Lindenmayr in Cascajo Cave *Franz Lindenmayr*

From above to below on a lava cascade, Guinevere McDaid, Theofilos Toulkeridis, Scott Linn and Geoffrey Hoese. *Dave Bunnell*

CASCAJO CAVE

Picture Katling



Enthomological studies

Mapping

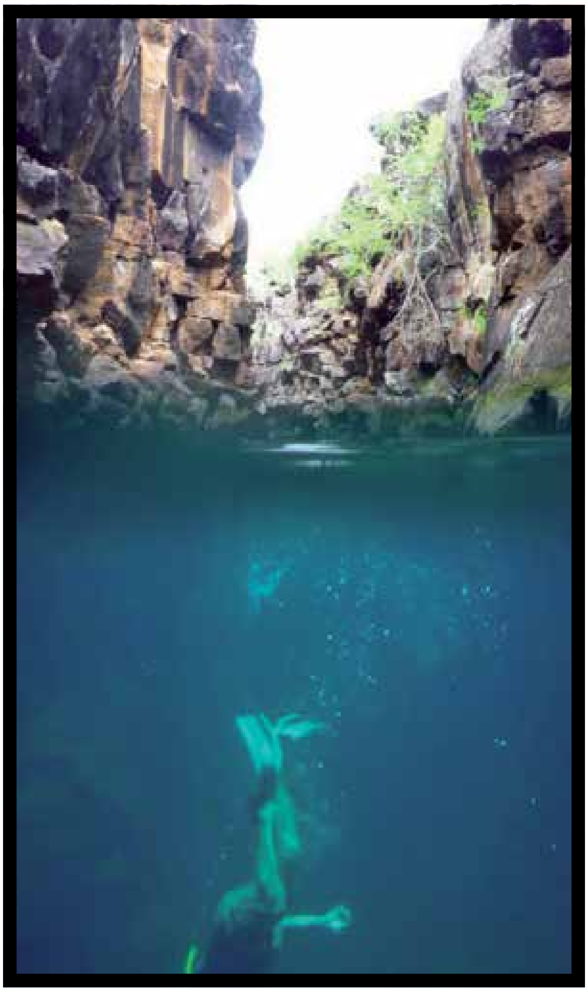
Pre-symposium participants

Owl

LAS GRIETAS

Backview of Yamirka Rojas diving at Las grietas — *Dave Bunnell*

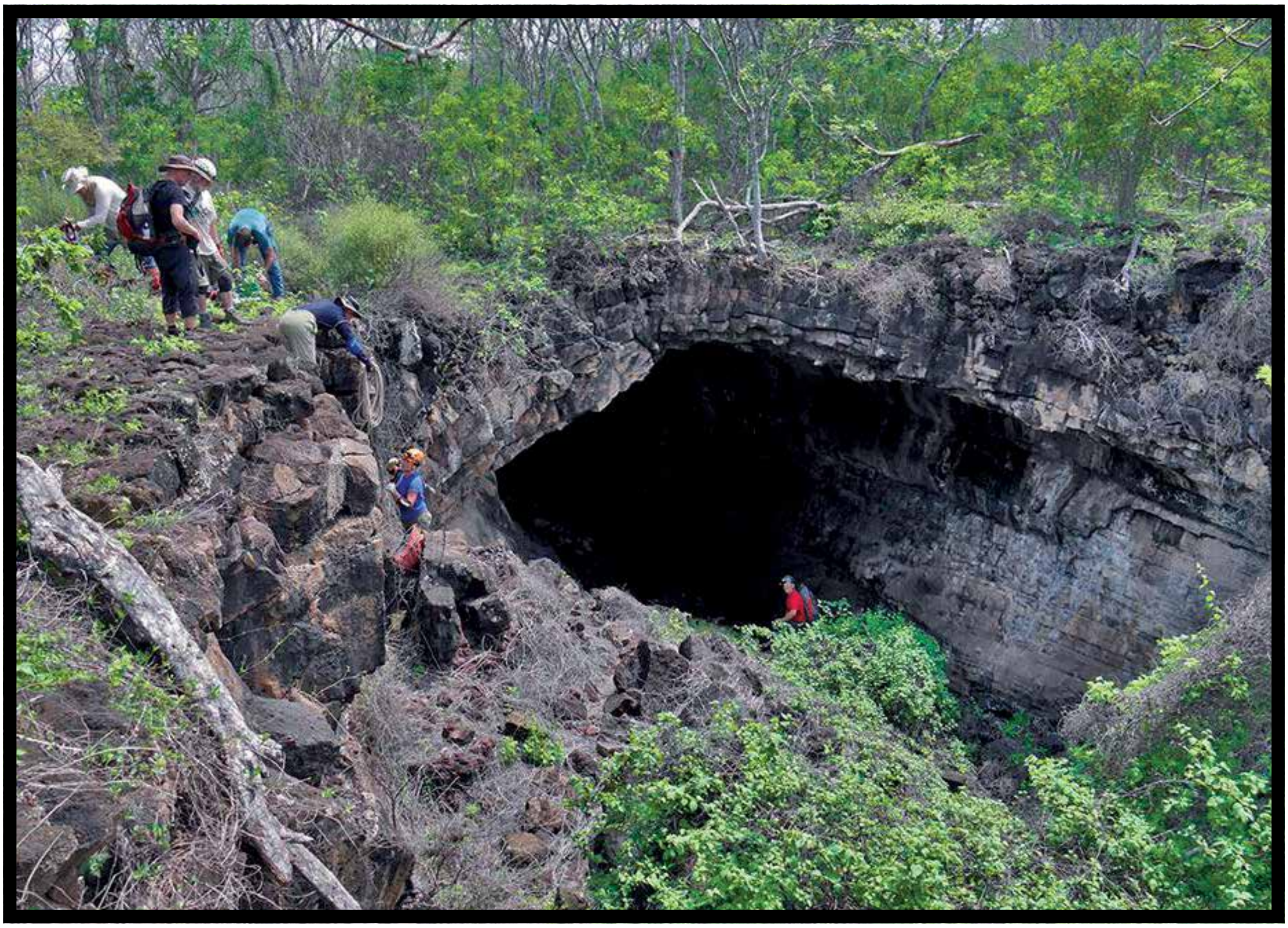
A newborn moment of Rick Haley — *Aaron Addison*



Above & below scalerel view of Las grietas — *GeoffHoese*

Over view of Las grietas — *Phil Collett*

LA LLEGADA CAVE



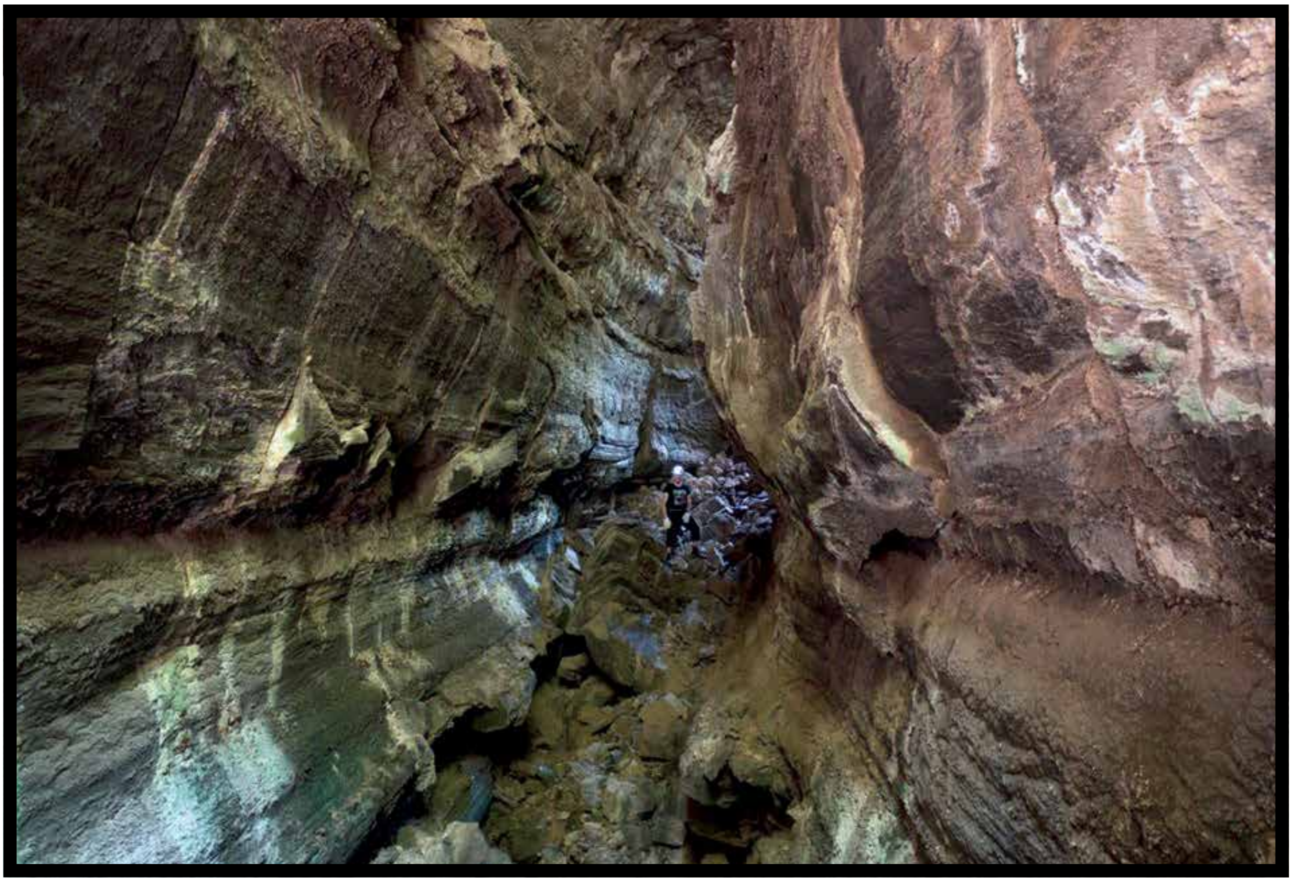
One of the multiple entrances of La Llegada cave *Dave Bunnell*

Guin McDaid *Aaron Addison*

Rick Haley and Scott Linn *Aaron Addison*

LA LLEGADA CAVE

Árni Björn Stefánsson for scale *Dave Bunnell*

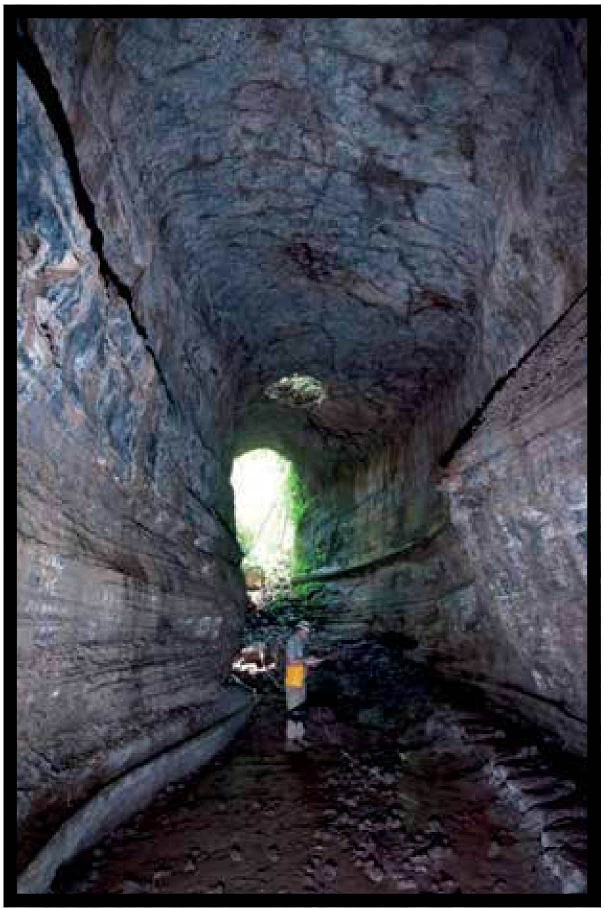


Árni Björn Stefánsson for scale *Dave Bunnell*

LA LLEGADA CAVE

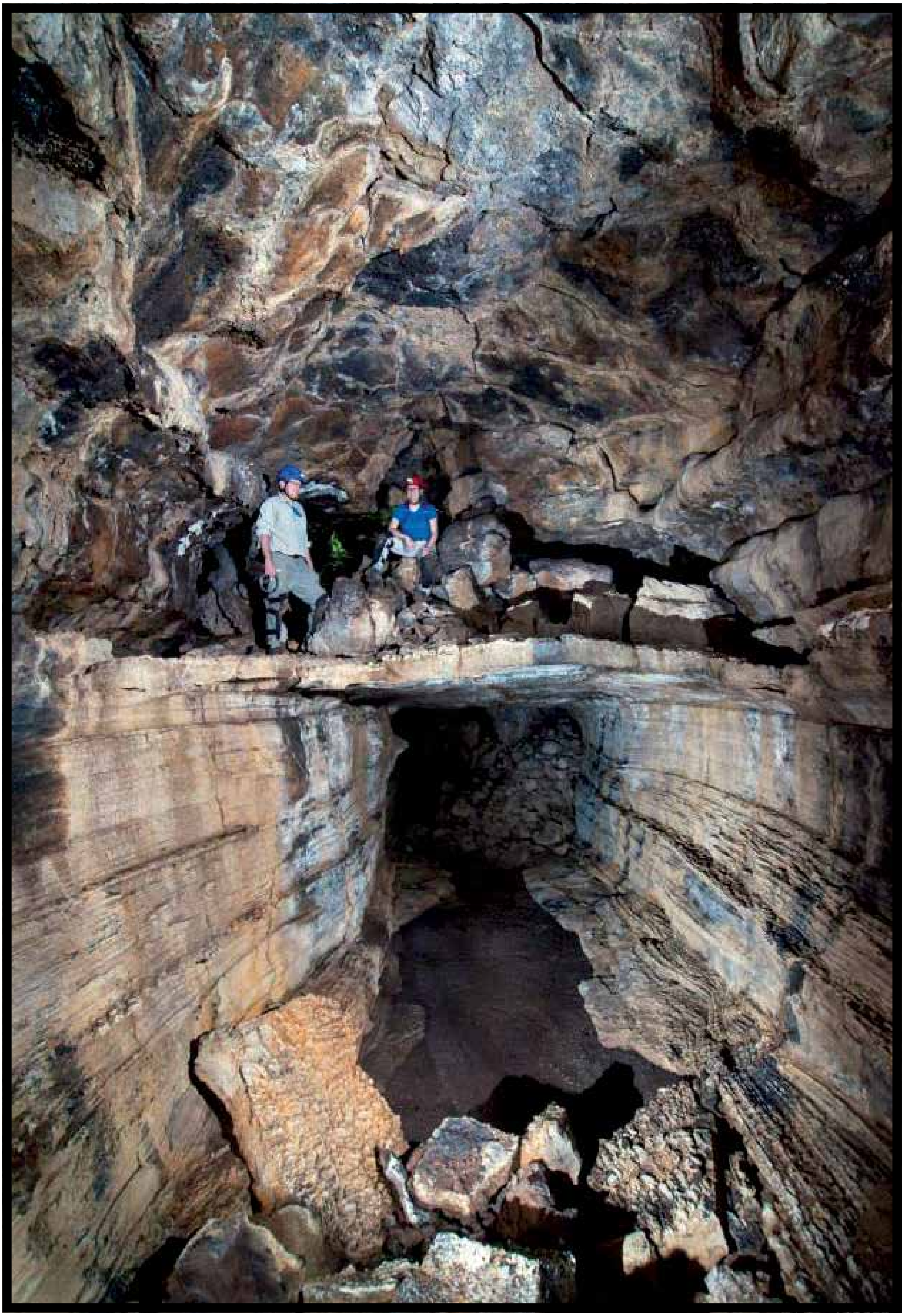
Mapping team on the move *Geoff Hoese*

Scott Linn and Bob Osburn mapping *GeoffHoese*



Bob Osburn sketching *GeoffHoese*

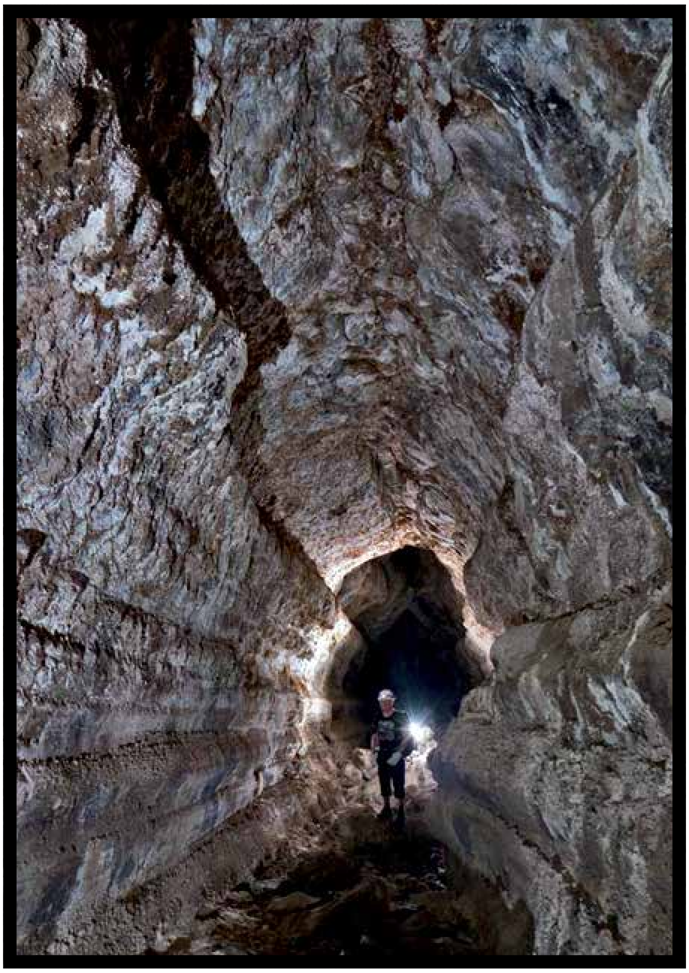
LA LLEGADA CAVE



Steve Taylor and Joann Jacoby, search for insects *GeoffHoese*

LA LLEGADA CAVE

Mapping in different levels *Dave Bunnell*



Árni Björn Stefánsson *Dave Bunnell*

Árni Björn Stefánsson at a collapsed part of La Llegada *Dave Bunnell*

LA LLEGADA CAVE

Árni Björn Stefánsson *Dave Bunnell*

Mapping team after a hard walk from La Llegada cave at the cinder quarry *Dave Bunnell*

EL MIRADOR CAVE (Kübler cave)

Aaron Addison georeferencing Steve Taylor

Entrance kübler cave Steve Taylor

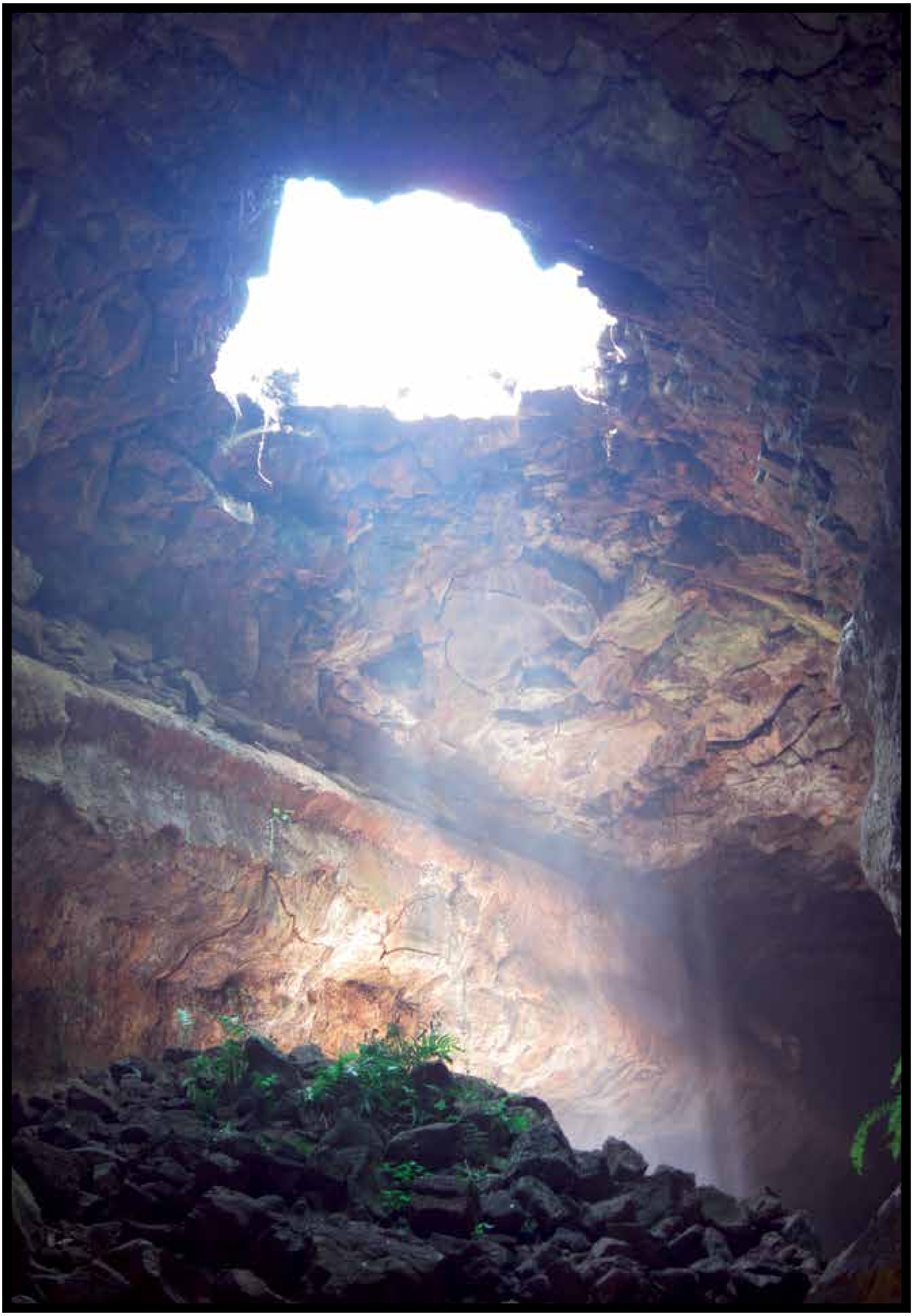
Map overlay Aaron Addison

A relaxing moment Steve Taylor

Steve Taylor

Steve Taylor

EL MIRADOR CAVE (Kübler cave)



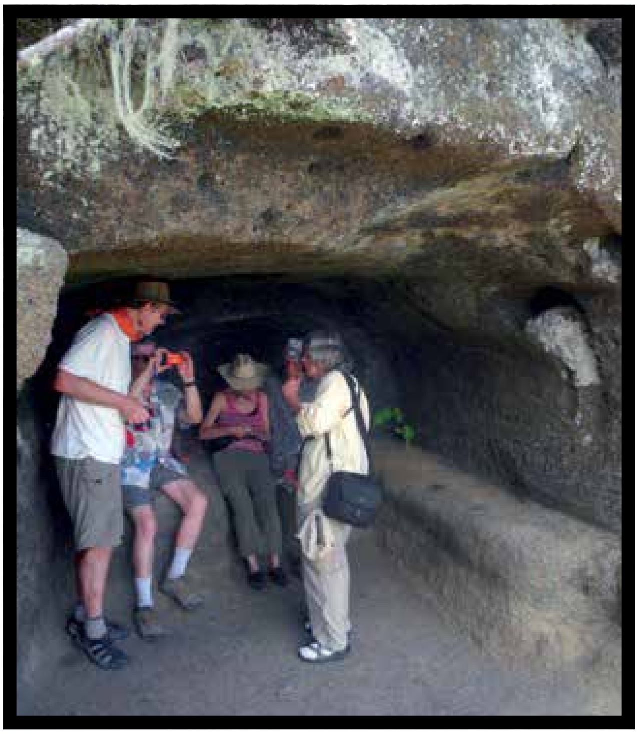
Roof collapse of Cueva Mirador *Steve Taylor*

FLOREANA ISLAND

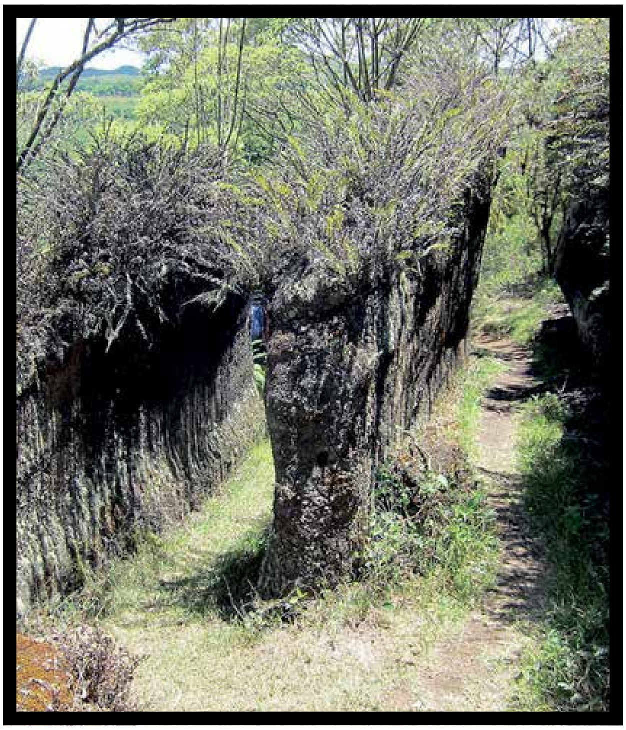
symposium participants

symposium participants

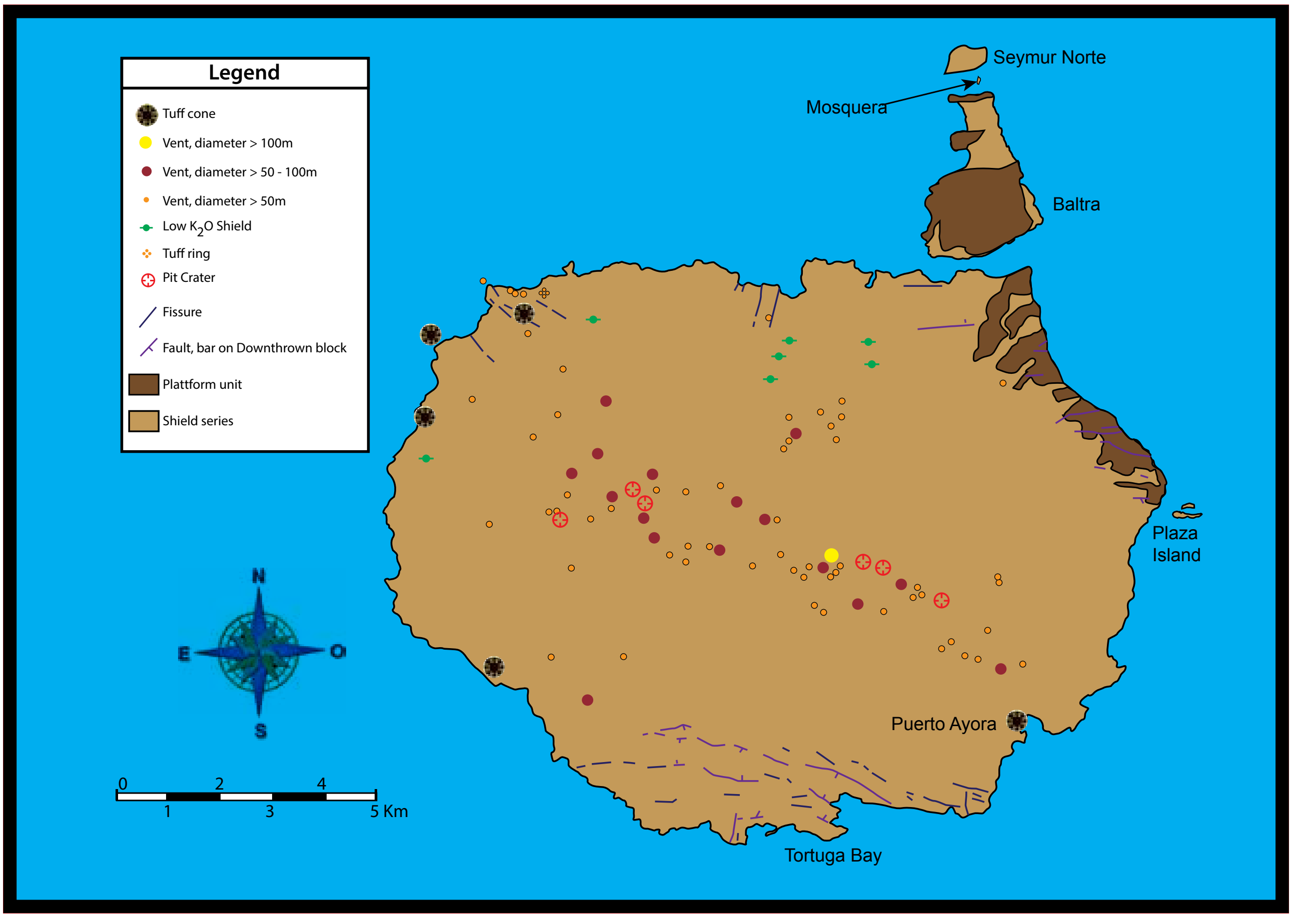
symposium participants



symposium participants



Floreana island *Phil Collett*



Schematic geologic map of Santa Cruz, Baltra, Mosquera and North Seymour islands and the distribution of volcanic vents *GEO1-T.T.*

Los Gemelos sink holes, highlands Santa Cruz *Theofilos Toulkeridis*

Sunday 16th of March

Flight to Baltra,, transfer with boat crossing the channel Itabaca and later traveled by bus or taxi to Puerto Ayora. Arrivals and accommodation were previously arranged for reservation. The ISV hotels are Red Booby, Flamingo, Salinas, Galapagos and Sueños Silvestres. For those who would like to relax and see a part of the flora and fauna of the islands, they may visit the Charles Darwin Research Station (optional). Registration was $620US which includes accommodation (six nights 16-22 of March), opening reception, symposium, transport to and from caves (and one ride back to airport), dinners, lunch boxes and breakfasts, boat transport from Santa Cruz to Isabela Island and back, let by Theofilos Toulkeridis and Aaron Addison as well as members of the organizing caving team.

19.00 Welcome cocktail at Hotel Flamingo

symposium participants

symposium participants

symposium participants

symposium participants

symposium participants

Monday 17th of March

7.00 a.m. Breakfast at Hotel Flamingo

Walk (10 minutes) taxi ride (2 min trip, 1$) to Symposium site "Miguel Cifuentes Arias" of the PNG, close to entrance to the Tortuga Bay path

8.30 a.m. Welcome by the main Galápagos authority, Dr. Arturo Izurieta (Ph.D.), Director of the Galápagos National Park and by the organizers

9.00 a.m. Symposium, Conferences, Posters among others.

Coffee breaks at site

13.00 p.m. Lunch at Primicias

19.30 Dinner at Restaurant Garrapata, typical Galápagos (sea) food (other choices are of course also available, please let us know about food allergies etc.)

Aaron Curtis presebting his work *Steve Taylor*

Dave Bunnell at the conference *Steve Taylor*

Community environmental education center "Miguel Cifuentes Arias" *Steve Taylor*

Conference rooms at the community center for environmental education "Miguel Cifuentes Arias" *Steve Taylor*

Recent Explorations in the Galapagos Islands

Aaron Addison
Cave Research Foundation

Lava cave explorations in the Galapagos Islands have yielded some interesting finds in the past five years. This presentation will summarize the current status of exploration and survey\documentation in the islands through 2014, with a focus on the islands of Santa Cruz and Isla Isabela. A brief overview of the ongoing science investigations will also be discussed.

The keokeo lava tube system in Hawaii

Peter Bosted[1], Tomislav Gracanin[2], Veda Hackell[2], Tim Scheffler[3]
[1]PO Box 6254, Ocean View, HI 96737 USA (peter@cavepics.com)
[2]Houston, Texas,USA (tnv@att.net) [3]University of Hawaii, Hilo, Hawaii, (scheffle@hawaii.edu)

The Big Island in the U.S. state of Hawai'i is home to the majority of major lava tube systems in the world. The second longest system in the world, the Kipuka Kanohina system, originates in the SW rift zone of Mauna Loa, within the Kahuku Unit of Hawaii Volcanoes National Park (HAVO). Recently, another major system has been identified, also originating in the SW rift zone. The approximate location of the system is shown as the thin and thick black lines in Figure 1. The system is formed in the Qk2 Mauna Loa flow which extends from the presumed source at Pu'u o Keokeo (altitude of 2,200 m), all the way down to the ocean, some 28 km distant. The estimated age of the flow is 1,500 to 3,000 aBP (Sherrod 2007).

Some of the lava tubes in the system were used by the original Polynesian settlers, possibly as long as 1,000 years ago. Charcoal from torches can be found in many of the low elevation passages, as well rings of stones which held gourds to collect water, and some flatterened areas that indicate the use of caves for shelter. In most of the 1800's and 1900's, the entire flow was on the property of the very large Kahuku Ranch. Ranch-hands and farm children sometimes visited the caves. The upper portion of the Keokeo flow became part of HAVO in 2004. The lower portion was sold to private developers in 2006.

Systematic exploration of the Keokeo system began in 2011. Some entrances were found from satellite and aerial photos. The great majority of them were found on surface hikes, or by entering one entrance and coming out another one. To date, about 300 entrances have been identified. Of these, about 150 have been explored and surveyed. For the entrances within HAVO, an initial reconnaissance of all of the passages accessible from a given entrance was made with archaeologist Dr. Tim Scheffler, in order to determine if sensitive cultural resources were present. There have been about 150 field trips to the flow. About 29.5 km of passage has been mapped in segments ranging from less than 10 m to over 4 km in length. Ongoing exploration continues to connect segments together.

The cave system features large trunk passages up to 20 m wide and 15 m high. The floor of the large passages is most commonly covered in ceiling breakdown. At intervals ranging from 20 m to almost 1 km, ceiling collapses breached the surface, making entrances ranging from small-diameter skylights to large pukas, up to 30 m long and 15 m wide (see Fig. 2). Some of the large size of the trunk passages can be attributed to rapid down-cutting through an a'a layer as the cave

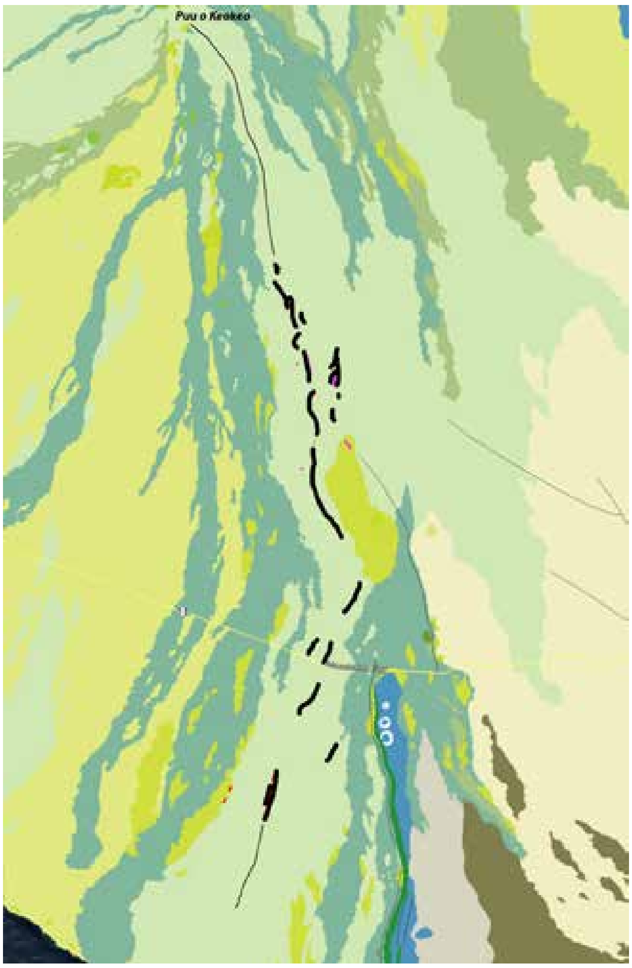


Figure 1. Geologic overview of the Keokeo flow on the south slope of Mauna Loa. The thick black lines show the approximate location of explored passages, while the thin black lines are likely extensions to the north and south. The distance from the top to bottom of the figure is about 30 km, and north is up. The Keokeo flow is colored light green. Older flows are yellow and green, while modern flows are colored blue. Highway 11 crosses the figure from left to right just below the middle.

was forming. The rubble layer was coated with linings that sometimes break off to reveal the bright orange rubble behind, as illustrated in Fig. 3. Above the trunk passages, there are numerous smaller interconnected passages, formed in a stack of pahoehoe and a'a sheets up to seven layers thick.

Figure 2. Stephan Kempe (in red) and Tim Scheffler above the largest entrance of the system found so far. Photo by Peter and Ann Bosted.

Figure 3. Illustration of wall-lining peeling away to reveal a thick layer of red ʻaʻa rubble behind. Bob South is the model. Photo by Peter and Ann Bosted.

The lava tube passages often contain white, orange, and sometimes pink or green minerals, including calcite, gypsum or opal, although epsomite and mirabilite can be also found.

The Keokeo flow covers a large elevation range (from sea level to about 2,200 m), but the endemic Hawaiian Ohiʻa tree can be found throughout almost the entire range. Some of the roots are well over 10 m long and bundles up to 30 cm in diameter occur. The tree roots are an important source of nutrition and water for a host of cave-adapted species, including crickets, spiders, isopods, moths, and planthoppers. Well-preserved fossil bird bones are also sometimes found, especially in deep passages far from entrances, where they are protected from weathering. Some of these may be from now-extinct species. Microbial mats are found throughout the system.

With about 150 or more entrances to investigate, there is clearly much more work just to finish the exploration, mapping, and photo-documentation of the Keokeo system. Meanwhile, there are many opportunities for detailed studies of the geology, biology, paleontology, and archeology.

Thanks to the numerous cavers who helped with mapping and photography. We thank the National Park Service for their strong support.

Lavacicles: How many flavors do they come in?

Dave Bunnell

In many descriptions of lava tubes, "lavacicle" is used to denote virtually anything that hangs from a ceiling. The speleothems described by this catchall term can be divided into many categories based on their morphology. With this paper I am hoping to come up with a consensus on terminology and also resolve just how many distinct mechanisms may produce lava stalactites, which has been proposed as a more useful term.

Before discussing subtypes, I want to clarify that while "lavacicle" may refer to both primary and secondary speleothems, lava stalactite is limited to primary ones, composed of lava, and formed by mechanisms not seen in solution caves. The types of secondary or depositional stalactites seen in solution caves certainly can be found in lava tubes, but tend to be much smaller and often composed of minerals less typical of solution caves. Many are even biogenic in origin.

So I will propose that there are four main types of lava stalactites, and possibly two others that might be deserving of their own subtype.

Shark-tooth stalactite. Small driblets of lava can form as a molten ceiling is cooling, either during the initial flow or when a later flow through an existing tube causes remelting. As the level of flowing lava inside an active tube fluctuates, it may coat protrusions on the ceiling with a thin veneer of lava, building them up by accretion. This results in a broad stalactite, usually tapering to a point. A cross section of such a stalactite will show successive layers, just as tube passages may contain layers of linings. These stalactites tend to occur in dense clusters rather than solitary individuals, and can vary from half an inch to several feet in length.

Splash Stalactite. Frothing, turbulent lava flowing through a tube, or breakdown falling into molten lava, can splash existing stalactites on the walls or ceiling, either of the tubular, helictite, or shark-tooth variety, coating them with additional lava. Or there may have been no pre-existing stalactites, making this a primary mechanism in some cases. Stalactites are emplaced as dripping lava hardens. The ends may be quite rough and irregular, or come to a fine point, depending on viscosity of the lava and its cooling rate.

Tubular Lava Stalactite. Tubular stalactites are common in many lava tubes. They have a tubular shape and are (at least initially) hollow, ranging in diameter from 0.4 to 1 centimeter. Beneath the recently hardened skin that forms the walls of a newly drained lava tube, boiling of semi-crystalline lava may continue. Gases force the material out of this partially cooled matrix in a tubular fashion, with growth rings evident on the skin of the stalactite. Considerable material may be carried out of the straw and pile up on the floor beneath, forming a drip stalagmite. These are somewhat analagous to soda straws, which form by deposition of calcite in limestone caves, and the term is sometimes applied to the lava variety. The calcite variety often plugs up and becomes the nucleus for stalactites, but this mechanism can't account for the genesis of any common variety of lavacicle

Tubular Lava Helictite. Helictites are eccentric or "vermiform" forms of stalactites that twist and turn rather than growing straight down. They typically begin as tubular lava stalactites, but crystallization of the emerging lava as it cools pushes the lava in different directions. Often groups of these helictites will bend in the same direction down the passage, suggesting an influence of wind moving through the tube. Small helictites are fairly common in tubes, but ones more than a foot long are rare. Helictites rarely have driblet stalagmites lying underneath. The helictite begins to form when the flow in the tube has slowed down to the point where crystallization controls the shape, and that usually means there is too little flow to also drip to the floor beneath.

Finally, I am proposing three additional categories, one common and two rather uncommon:

Remelt stalactite: Formed when a hardened ceiling remelts from heating due to a newly active flow passing beneath it. These are solid, rather than tubular, tend to be rounded on the ends, are small and relatively uniform in size with an area. They might provide a core for shark tooth stalactites to form, but if no recoating of the initial stalactite occurs, it might make more sense to consider it its own subtype.

Blade stalactites: Blades have been classed as a type of distinctive speleothem that typically form on walls rather than ceilings, are often oriented vertically, and form in groups that are roughly parallel. They're thought to be a flow feature found near constrictions that increase the flow rate. Often blades protrude out in forms that certainly can resemble stalactites. However, these may be understood more as shark-tooth or splash stalactites that have formed on the underlying blade structure.

Girdled stalactite: Formed when a clump of airborne Pele's hair or other debris is caught on an existing lava stalactite and then inundated with flowing lava that binds the clump to the stalactite. The clump is oriented downflow. This rare formation may best be classed as a subtype of shark-tooth stalactite.

New Technologies and Approaches to Advance the Search for Volcanic Caves on Other Planets

P.J. Boston
Earth & Environm Sci Dept, New Mexico Tech, Socorro, NM, and the National Cave & Karst Research Institute, Carlsbad, NM, USA

Interest in possible caves on other bodies in the Solar System is of growing interest (Boston 2000, 2004; Cushing et al 2007; Haruyama et al 2009). Apparent volcanic caves on some bodies are produced by processes resembling those we experience on Earth, but on extremely cold icy bodies like Titan or Europa other processes may be at work. Finding and subsequently exploring such caves with robotic devices is of great interest to science and future human exploration at least to the Moon and Mars (e.g. Horz 1985; Boston et al. 1992, 2001; Léveillé and Datta 2009). Promising new approaches may facilitate future extraterrestrial speleological exploration: 1) thermographic contrast mapping from orbital or aerial platforms, 2) radar imaging of several types, and 3) robotic exploration.

Ground-based infrared camera trials have been conducted in New Mexico, West Virginia, Missouri, Greece, and the Atacama Desert, Chile. Balloon-borne trials were conducted in the Mojave. The technique shows promise for detection of Earth caves (Thompson & Marvin 2006). Modeling efforts of the Martian thermal environment to determine suitability of this method in the much colder temperatures of Mars (Cushing et al 2007; Wynne et al 2008). Applicability to ultra low temperature bodies with minimal thermal contrast remains to be demonstrated: Titan which has a very dense atmosphere, or Enceladus or Europa both of which have no atmospheres.

Radar imaging of gigantic frigid Titan, orbiting Saturn, suggests both cryovolcanism (e.g. Wall et al 2009) and subsurface structures (Burr et al 2009). Can processes on a body of water-ice bedrock and a surface of a bizarre mixture of organic compounds awash with alkane lakes and rain possibly produce structures resembling lava caves familiar to us on Earth and other rocky terrestrial bodies? A plausibility argument can be made and tested using orbital data and modeling.

Successful robotic access to caves, rock shelters, and other rugged and unpredictable surface terrain is essential to allow exploration of Mars and even for some extreme Earth sites (Dubowsky et al 2004; Parness 2010). Concepts like high energy-density polymer "muscle"- actuated hopping, self-deploying microbots for subsurface sensing and telemetering networks or unique clinging and climbing mechanisms are being developed. A field demonstration with JPL colleagues during 2014 will test gravity-independent inverted clinging robots in lava caves in New Mexico and California.

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Lava caves under the city of Auckland, New Zealand.

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New Zealand's largest city, Auckland, is built amongst some 50 volcanoes that were active as far back as 200,000 years. The most recent eruption was 5-600 years ago and lava caves have been found in flows dating from approximately 600 to 60,000 years ago. More than 250 lava caves have been recorded in the Auckland area. However, cities and shallow lava caves are not all that compatible and over the years, numerous caves have been badly damaged or destroyed by quarrying or by construction works for roads and buildings. Often, the caves that remained were regarded as convenient rubbish dumps or drains for stormwater and sewage. Until recently, lava caves were not officially recognised by Government even though some were of deep cultural significance to local Maori people and others had significant scientific values. This paper reviews some recent protection success stories and also some failures.

Siliceous speleothems in Ana Heva lava tube (Easter Island, Chile)

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1. Introduction

Easter Island or Rapa Nui, as it is known by the Polynesians, is located in the Pacific Ocean, at more than 3,500 km away from the Chilean coast. With a total surface of about 170 km2 and far more than 2,000 known lava-cave entrances, Rapa Nui has one of the world's highest densities of lava tubes. In the present work, we have studied the mineralogical and geochemical characteristics of peculiars siliceous speleothems from Ana Heva lava tube, located in the western side of the island. This cave, together with other nearby lava tube, forms a subterraneous system with almost 2 km of interconnected passages, with average dimensions of about 4 m wide and 2 m high.

2. Materials and methods

Whitish to yellowish coralloid-type speleothems were collected from the ceiling of the Ana Heva lava tube, 20 m apart from the cave entrance. The speleothems displayed on the basaltic host rock and thin water films were observed on their surface at the moment of sampling (Fig. 1A). On the other hand, a sample of blackish to ochre color like-flowstone dome showing layered internal structure was taken 40 m inward from the cave entrance (Fig. 1B). Micro-Raman spectroscopy, FT-Raman, FT-IR, and XRD analyses were performed at the Associated Unit to the Center of Astrobiology (CSIC), University of Valladolid (Spain). SEM microphotographs and EDX micro analyses were carried out at the Technical Services Area of the University of Almeria (Spain).

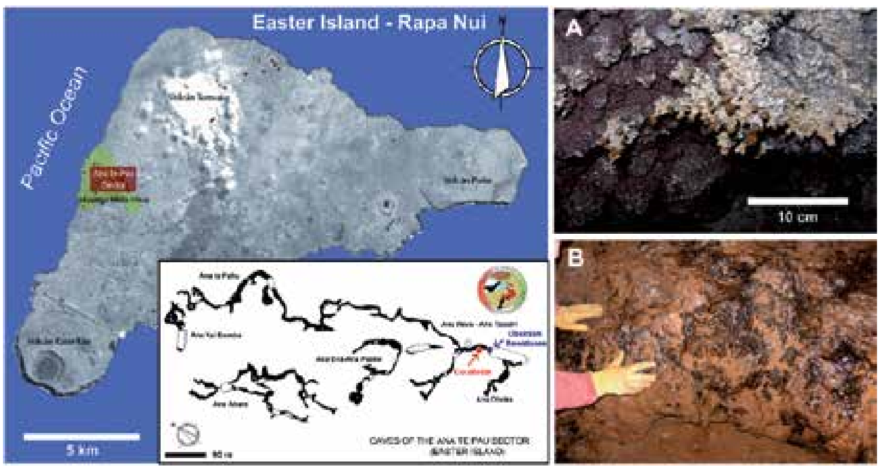
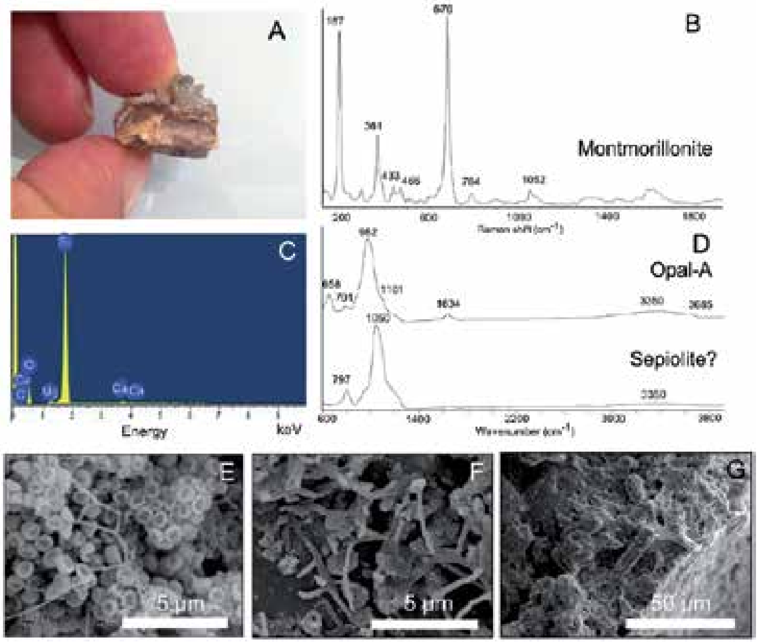


Fig. 1. Location and topography of Ana Heva lava tube (W Easter Island). (A) Coralloid-type speleothems and (B) siliceous like-flowstone domes studied in the present work (Photos: Jabier Les).

3. Results and discussion

The coralloid-type speleothems from Ana Heva lava tube (Fig. 2A) were analyzed by FTRaman, revealing the presence of motmorillonite [(Na,Ca)0,3(Al,Mg)-2Si4O10(OH)2·nH2O] (Fig. 2B). The EDX microanalysis found Si, O, Ca and Mg, corroborating the mineralogical nature of these speleothems, as well as trace of C (Fig. 2C), bounded to the presence of organic matter and biomineralization mechanisms (Miller et al. 2013). According to FT-IR analyses, these coralloids are composed of water-containing amorphous silica-glass (opal-A, SiO2·nH2O) and the possible presence of sepiolite (Mg4Si6O15(OH)2·6H2O) (Fig. 2D). Micro-Raman analysis was not possible due to intense fluorescence of the sample, suggesting high content of organic compounds, while XRD revealed low grade of crystallinity. This structural disorder is also linked to microbial activity. SEM images of the coralloid-type speleothems revealed a variety of microbial morphologies (Fig. 2E, F, G), which suggests their involvement in a biomineralization process as pointed out by Miller et al. (2013).

In regard to samples of dark like-flowstone features (Fig. 3A), microscopic observation revealed that these domes are composed of alternating thin layers of obsidian (SiO2 plus MgO2 and Fe3O4) and an admixture of ferromanganese oxyhydroxides (hematite + goethite + Mn-oxides) (Fig. 3B), as revealed by Raman spectroscopy (Fig. 3C) and EDX microanalyses (Fig. 3D). No evidences of biological activity have been observed. XRD only found traces of goethite and amorphous substances. Taking into



Fig, 2, A. Coralloid from Ana Heba lava tube; B. Raman spectra showing montmorillonite; C. EDX microanalysis; D. IR spectra showing Opal-A and the possible presence of sepiolite; E, F, G. SEM images revealing microbial morphologies.

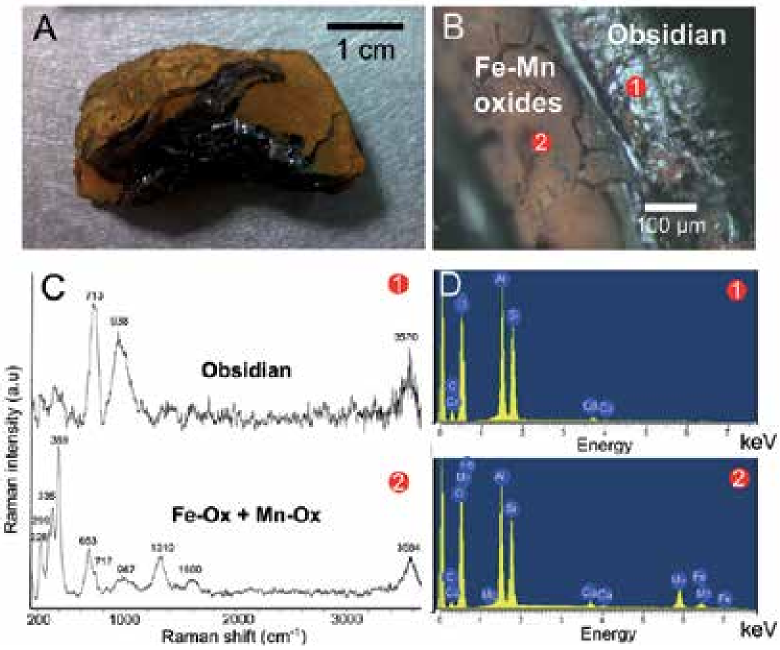


Fig. 3. A. Obsidian like-flowstone domes; B. Position of Raman and EDX microanalyses; C. Raman analyses; D. EDX microanalyses.

account that obsidian is produced by felsic lava that cools rapidly giving rise to minimum crystal growth; it is very probable that these speleothems formed during very early stages of the lava cave, when temperature was still high. Dripping of melted lava produced the segregation of obsidian. This process also caused the enrichment in Fe ad Mn during some stages. Subsequently, the obsidian layers were covered by further lava flows.

4. Conclusions

Peculiar siliceous speleothems have been found in Ana Heva lava tube. Corralloid-type speleothems display many evidences of biological activity and biomineralization. Evaporation of a SiO2-rich water sheet flowing on these speleothems could also play a main role in their genesis. On the other hand, dome-shape features composed of obsidian probably formed during the early stages of the lava tube from magmatic fluids.

Acknowledgements

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Detection of volcanic caves in Mexico City using seismic tomography and MASW methods

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The "Cerro de la Estrella" is a volcanic dome located within the Iztapalapa Municipality in Mexico City. It is formed by andesitic lava flows intercalated with basaltic scoria, pyroclastic flows and fall deposits. In the study area many collapses have been reported, associated with the presence of large cavities related to the structure of the volcanic deposits. The origin of these structures is probably due to the high concentration of volatiles and gases during the emplacement of the andesitic materials. Apparently, gas bubbles of various sizes had been trapped within the fractured volcanic rocks creating secondary structures of various magnitudes (branches and vaults). The stability of the structure is close related with the degree of fracturing, erosive processes and gravity determining their susceptible to collapse. In this work we present the application of two seismic techniques for the detection of these volcanic caves that allowed to assess the geological hazard associated with their instability.

The seismic tomography and multichannel analysis of surface waves (MASW) methods were very useful to locate a volcanic cave in a high populated urban zone, Iztapalapa. For the tomography a series of 16 geophones with 17 shots throughout a line array was designed. Many seismograms were obtained and the first arrivals were inverted. With the MASW-2D method the dispersive nature of the surface waves were analyzed. The obtained results with both methods were compared among a 2D section of P-wave velocity (Vp) from seismic tomography and the quasi-2D sections of S-wave Velocity (Vs) obtained by MASW. Different anomalies were identified, in the location corresponding to the cavity, by the decrease of shear wave velocities (Vs) and compressional waves (Vp) for each method. The application of both methods allow to identify the average thickness of the roof structure of the cavity from surface. The corroboration of the obtained results was made by detailed mapping in the study area and geological characterization. This prospection study allowed to obtain a pattern of cavities by the mapping of the roof thickness of these volcanic structures and to estimate the geological hazard related to their possible collapse in the study area.

Holes in the Landscape: A Metageography of Volcanokarst

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Although volcanokarst, consisting of rheogenic pseudokarst (Halliday 2004, 2007) or other forms (Reffay 2001) has a widespread geographic distribution on Earth, there remain areas where it might be expected, yet where records are minimal or absent. The global distribution of documented volcanokarst reflects the occurrence of suitable host rocks, particularly relatively young extrusive volcanic rocks of Cenozoic age (<66 Ma). Although surface landforms such as collapse pits and karren-like features may occur on a range of volcanic lithologies, extensive volcanic caves, particularly evacuated lava tubes, are associated primarily with youthful low-viscosity lavas of a basic geochemical composition. Accordingly, the geography of vulcanospeleologic research and records should provide a proxy for the distribution of the necessary host rocks.

Comparison of maps of Cenozoic and other volcanic rock outcrops and those of contemporary plate tectonic boundaries (Figures 1 and 2) with the distribution of volcanic caves and other volcanokarst landforms documented primarily in the proceedings of the preceding 15 international vulcanospeleology symposia (Table 1) reveals some close associations, for example in western North America, southern Europe, East Africa, the Pacific and parts of Asia (Table 2), but it also allows identification of some areas where the anticipated volcanokarst morphologies are not yet represented appropriately in this literature. Notable among these under-represented areas are Central America and the Caribbean, the Indian subcontinent, insular Southeast Asia and parts of northern Africa. Rather than indicating an absence of volcanokarst in these regions, this selective record, which admittedly does not encompass all potential sources, reflects explicable foci within the geography of contemporary vulcanospeleologic studies, while also suggesting that the apparent "gaps" in global representation may indicate fruitful locations for future individual and collaborative research.

Beyond the broad regional picture, preliminary analysis suggests that the following countries, in particular, may have further potential for as-yet undocumented volcanokarst assemblages: Canada, Nicaragua, Colombia, Peru, Norway, Turkey, Malaysia and the Philippines. Additionally, there is a high probability of additional volcanokarst identification in Australia, the insular Pacific, East Africa, Russia, Indonesia and China.

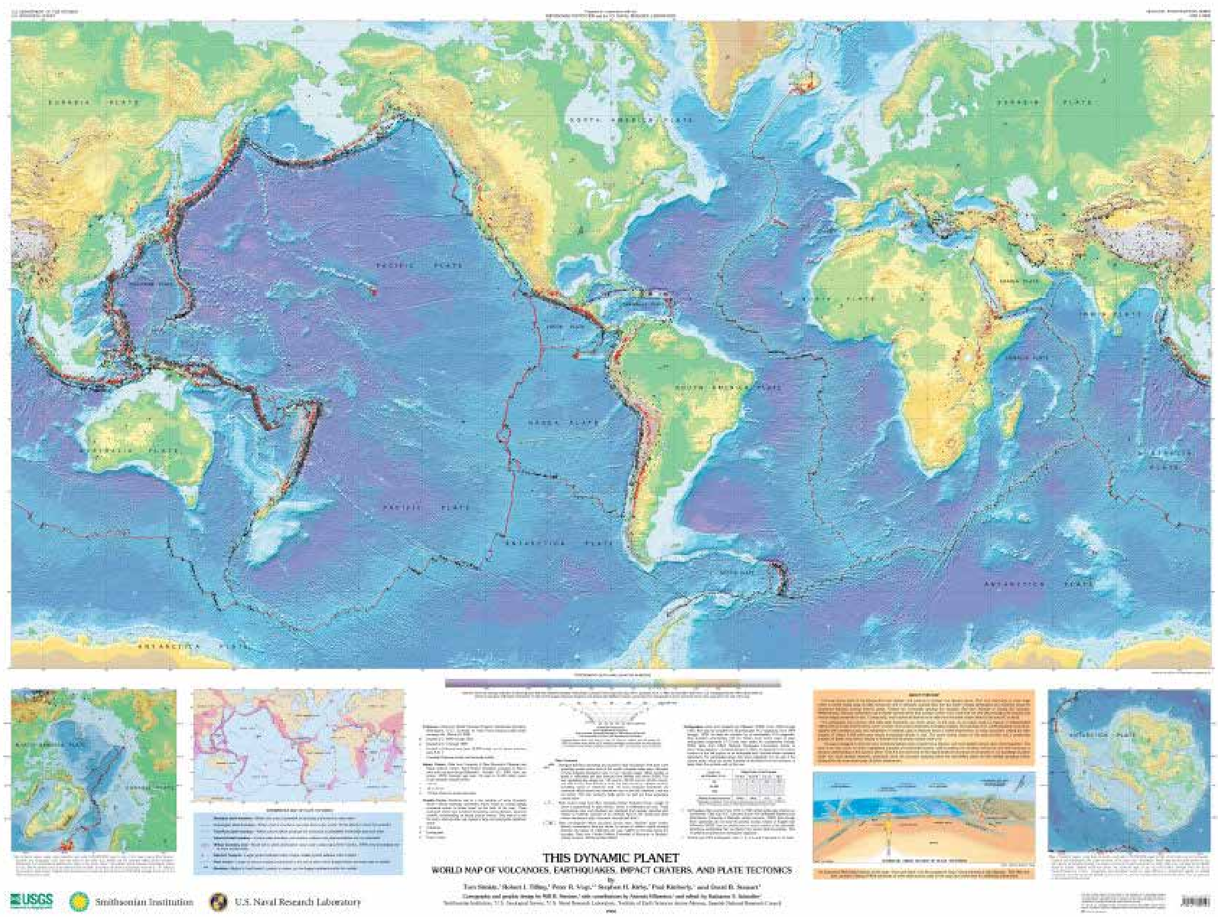

Figure 1. Volcanos, Earthquakes and Plate Tectonics. U.S. Geological Survey.

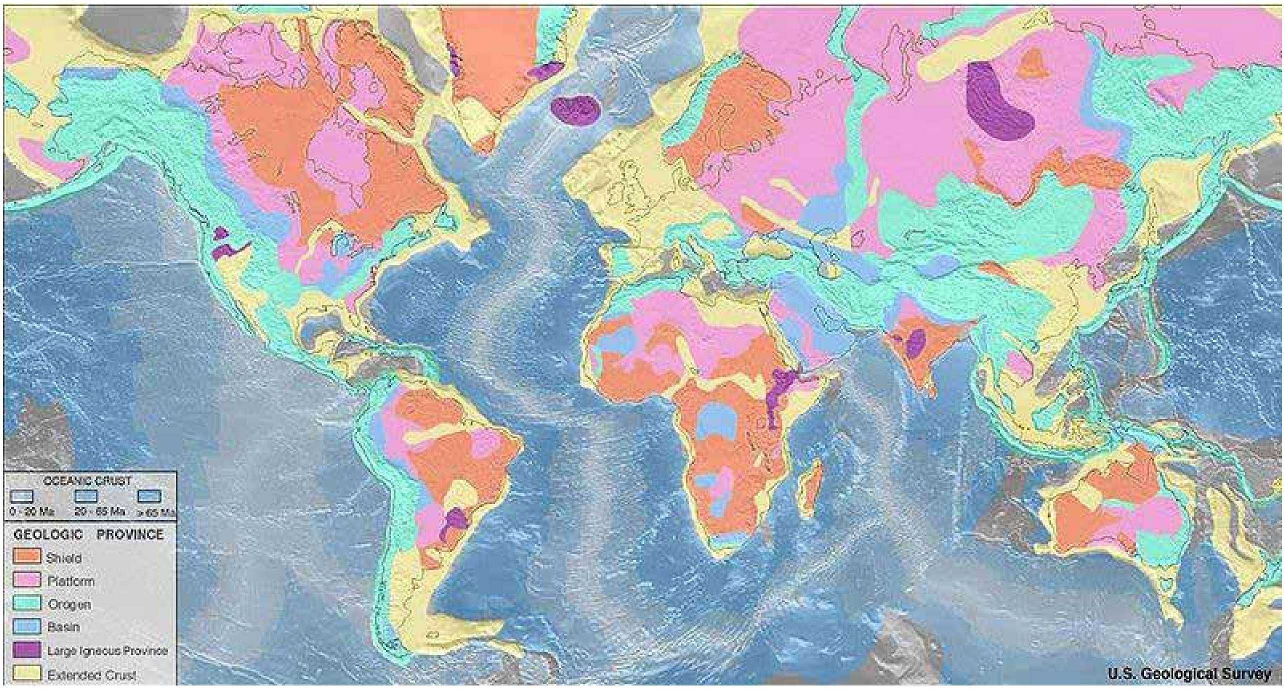

Figure 2. World Geologic Provinces. U.S. Geological Survey. (Note that not all orogenic provinces are areas of recent volcanism.)

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Table 1. Vulcanospeleology Conferences.

1972. White Salmon, Washington, USA
1975. Catania, Italy
1982. Bend, Oregon, USA
1983. Catania, Italy
1986. Izunagaoka, Japan
1991. Hilo, Hawaii, USA
1994. Santa Cruz de la Palma, Canary Islands, Spain
1998. Nairobi, Kenya
1999. Catania, Italy
2002. Reykjavik, Iceland
2004. Pico Island, Azores, Portugal
2006. Tepoztlan, Morelos, Mexico
2008. Jeju, South Korea
2010. Undara NP, Queensland, Australia
2012. Amman, Jordan
2014. Galapagos, Ecuador

Table 2. Documented Volcanokarst Locations

North America: USA: Washington, Oregon, Hawaii, California, Idaho, Utah, New Mexico, Arizona; Mexico, Canada.

Central America: Costa Rica.

South America.: Argentina, Chile.

Pacific: Easter Island, Galapagos, Micronesia, Samoa.

Australia: Queensland, Victoria , New South Wales, South Australia. New Zealand.

Europe: Canary Islands, Azores, Madeira, Iceland, Surtsey, Italy, Bulgaria, Romania, Hungary, Scotland, Russia, Georgia.

Africa: Ethiopia, Kenya, Rwanda, (Mauritius, Comoros, Reunion, Indian Ocean).

Middle East: Jordan, Israel, Syria, Saudi Arabia.

Asia: China, Japan, S. Korea (Jeju), Vietnam, Indonesia.

Biospeleothems of allophane and Fe oxi-hydroxides in the Galeria da Queimada lava tube (Terceira, Azores).

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Abstract

Stalactites, stalagmites, columns, gours and flowstones are present in the Galeria da Queimada lava tube, which lies in the Fissural Basaltic Zone (Nunes, 2000) at the centre of Terceira Island (Azores) (Fig. 1). This lava tube (640 m long, 0.3-2.5 m high and 0.26-10.9 m wide) originated in a basaltic lava flow dated to 4480±40 y BP (Calvert et al., 2006).

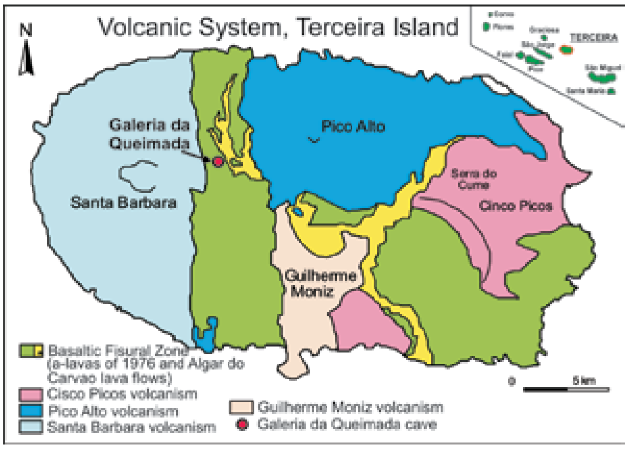

Fig. 1. Location of "Galeria da Queimada" lava tube on Terceira Island (Azores). Geological map modified from Nunes (2004).

The speleothems examined in this work are the tube's stalactites. These vary in their hardness and colour (from white, to yellowish [Fig. 2A], ochre, black, and a range of reds and oranges [Fig. 2B]), and are aligned along cracks in the tube's roof. Their growth relies on drip water entering the tube via the roots of plants. The mineralogy and petrology of these stalactites was studied.

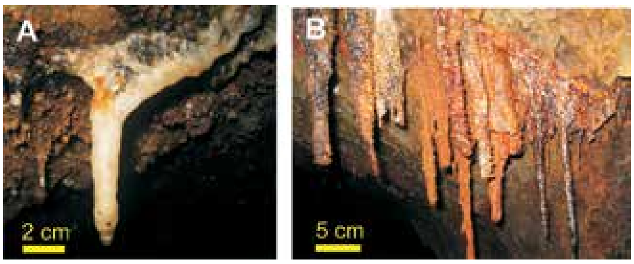

Fig. 2. Stalactites of Galeria da Queimada lava tube. (A) White to yellowish stalactite. (B) Red, orange and black stalactites aligned along cracks in the tube's roof.

XRD analysis showed very simple diffraction patterns with broad bands. Two types of poorly crystalline mineral were detected: allophane and Fe oxi-hydroxides. The allophane showed a diffraction pattern with two prominent bands, the first at 15-35° 2θ, peaking at 26-27° 2θ (3.3 Å), and a small band at 35-45º 2θ with a maximum at 40º 2θ (2.2 Å). Two weak peaks were also seen at 8-9º 2θ (10.15 Å) and 20º 2θ (4.41 Å), the consequence of small amounts of halloysite. The Fe oxi-hydroxides were defined by patterns with bands at 25º and 45º 2θ, peaking at 34-35º 2θ (2.50 Å). Occasionally, two incipient bands were seen: a broad band peaking at 35-36° 2θ (2.50 Å), and a smaller band peaking at 62-63° 2θ (1.49 Å). These bands indicate the presence of incipient "2-line" ferrihydrite.

Micro-Raman spectrometry analysis confirmed the presence of allophane and revealed abundant kerogen. This disordered biogenic carbon was defined by a D1 vibrational band (1.328 cm^{-1}) and G and D2 bands (1600 and 1623 cm^{-1}).

Scanning electron microscopy showed the structure of the stalactites to take the form of intercalated, compact thin rings and porous rings (3-15 µm) (Fig. 3A). The allophane and Fe oxi-hydroxides in the compact rings took the form of individual microspheres (≤0.5 µm) and botryoidal aggregates (Fig. 3B). The porous rings were formed by filamentous bacteria (Fig. 3A) fossilized in both minerals. These bacterial filaments were of varying diameter, the result of different degrees of precipitation on the bacterial sheaths. Biofilms and exopolysaccharides (EPS) were found between the bacterial filaments (Fig. 3C). Manganese oxide spheres (Figs. 3C and D) and masses (1-15 µm) accompanied the allophane and Fe oxi-hydroxides in both ring types.

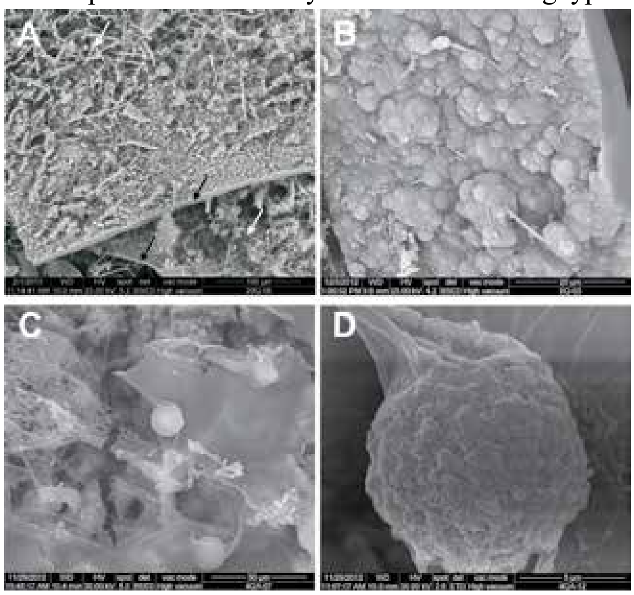

Fig. 3. SEM photomicrographs of stalactites. (A) Structure of the stalactites to take the form of intercalated, compact thin rings (black arrows) and porous rings formed by bacteria filaments (white arrows). (B) Compact rings took the form of botryoidal aggregates of allophane. (C) Detail of biofilms and exopolysaccharides (EPS) found between the bacterial filaments in the porous rings. Manganese oxide spheres are mixed with these biofilms, EPS and filamentous bacteria. (D) Detail of a sphere of manganese oxides bonded to a biofilm.

EDX analysis showed the allophane to have an Al/Si atomic ratio of 1.02-1.86. According to Parfitt (2009), ratios close to 1 correspond to Si-rich allophane, while those close to 2 correspond to Al-rich allophane. Small quantities of Fe and Ca, and occasionally Mg, Ti, K and Na, were detected. The Fe oxi-hydroxides showed Fe/Si atomic ratios ranging from 2.5 to 6.21; low ratios indicate Si-rich ferrihydrite. The manganese oxide spheres also contained Zn and Ce. C from biofilms, EPS, filamentous bacteria and other microbial components, was detected in all samples studied.

Allophane is normally very rare in speleothem formations, but it is a typical alteration product in volcanic ash soils. Speleothems made of Fe oxi-hydroxides are more common. In the Buracos cave (Terceira Island), bacterial filaments attributed to Leptothrix spp. and Gallionella spp., very similar to those seen in Galeria da Queimada cave, are found in ferric speleothems.

Different microorganisms (bacteria and fungi) facilitate manganese oxide precipitation in neutral pH environments. These biogenic oxides facilitate Ce oxidation.

In conclusion, allophane, Fe oxi-hydroxides and manganese oxides form the stalactites of the Galeria da Queimada cave. The porous rings showing filamentous structures were formed by organic precipitation; the compact layers were formed by inorganic precipitation.

Acknowledgements

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Sea caves in basalt lavas of different structures

Gadanyi, P – Gyuk, P.

Under given sea abrasion conditions, the morphology of sea caves is mainly determined by the rock structures of basalt lavas.

Sea caves in columnar jointed basalt lava

Due to abrasion these caves grow in the colonnade structured jointing, where from large pieces of columns are fall into the sea, especially in times of storms. The stope up of the cave, however, is most probable to cease in the entablature, where the lava has a denser, irregular crack-network. In the entablature there are many cracks typically diverging upwards, which parts are more resistant for static hold. As a result of this, in most of cases the roof of the sea caves formed in the entablature, while the sidewalls are constituted by the colonnade.

Sea caves in irregular-jointed basaltic lava

In more irregular and densely fractured lavas, the collapses take place along the downward diverging contraction cracks. Because the cracks run into several diverse directions even on a small area of study, the growing of these caves is more haphazard in terms of speed and direction than it would be in the case of regularly fractured lava. Hence, the morphology of these caves is also irregular.

Sea cave in basaltlava delta

The examined sea cave in Dyrhólaey is likely to have formed in a hyaloclastic lava delta sequence, where the coexistence of several geologic prerequisites created ideal conditions for the development of the sea cave which inwardly hollows out. These geologic prerequisites are the following:

Compact, but jointed lava layers in small dip angle and in a sufficient thickness, which means that the layers are thin enough for the abrasive agents to break them up, but they are sufficiently thick to stabilize the cave's roof and sidewalls. These lava layers were broken up from below by the pressure of the invading seawater accompanied by the wedging action resulting from the air compressed into the layers' joints, where the air escaped from with an explosive violence. The up-breaking of the lava layers is proved by the chimney which opened in through them.

Rather thick hyaloclastite layers, in which the effective and rapid excavation of the sea cave took place.

Inwards from the cliff face the compact lava layers become gradually thinner, while, **in compliance with it,** the hyaloclastite layers become thicker. Because of these reasons the inner side of the alternating lava delta sequence was abraded more effectively than its outer side, therefore the cave's inner cross section is higher and wider than the first passage section.

The stable roof of the cave comprises two different compact lava layers which resisted the abrasive agents and, for this reason, did not break up.

The stability of the sidewalls is caused by the remnants of the compact lava layer segments which remained in the sidewalls after the layer's up-breaking, and subsequently cropped out in some places forming ledges.

Sea caves evolved by the quarrying of the basalt volcanic agglomerate, or looser structured (aa) lava parts from between the host compact basalt

In areas of volcanic agglomerate, debris or looser structured aa lava the morphology of the evolved abrasion sea cave will not depend on the crack direction of the enclosing lava mass, but on the shape of the loosely structured debris once surrounded by lava flow; i.e. with the abrasive removal of the debris the shape of the cave will reflect its mould. I studied these types of caves in Jeju Island, South Korea, Lanzarote Island, and on the coastline of Hraunsvík, Iceland.

Sea cave in pillow lava

Near Mount Valahnúkar, Iceland, a sea cave in pillow lava developed along a crack. The hyalo-structured crust shells are the most resistant outer parts of pillow lava and, due to sea abrasion, the basalt material falls out of the internal radial joints of these round arched shells. The hyalo-structured crust shells, therefore, have a vital role in the stability of the abrasion cave wall acting as a sort of stiffener or net, joining the loose and fractured material and protecting the cave from collapsing. Consequently, under given abrasive circumstances, the direction of the external hyalo-structured pillow lava shells, as well as the direction of joints in the fractured pillow lava will be decisive during the formation of the cave.

Sea cave in basaltic dyke

In the hydrovolcanic tuff, revealed along the coastline of Hraunsvík, Iceland, the lower part of the basaltic dyke is subject to abrasive destruction. The key role of this process is played by abrasive rock boulders, with a diameter of 20 to 70 cm, knocked against the cliffs by sea waves. Above the resulting 'material loss' and on the upper part of the basaltic dyke, fragments separated by contraction cracks (size 8 x 30 cm or 12 x 50) can be expected to be shaken out, they split up along the cracks perpendicular to the fissure, as a result of which the roof of the cave stopes up in the basaltic dyke along the hydrovolcanic tuff. As a result of the this process it is the basaltic dyke (harder and more solid but made up of blocks separated by contraction cracks) which is washed out faster than the hydrovolcanic tuff.

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Climbing catfish

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While conducting a project to document caves in Napo District, Ecuador, the authors observed a number of catfish climbing a steep flowstone waterfall in the dark zone of a cave. The waterfall was a minor infeeder to the small stream that flowed through the cave. On investigation the catfish were determined to be Loricariidae:Chaetostoma microps Günther,1864. We document the observation of this species exhibiting climbing behavior as well as the first observation of the family exhibiting climbing behavior in a cave. We also document the sympatry of this species and Astroblepidae:Astroblepus Pholeter Collette 1962.

Investigation on the lava tube caves in the Reunion Island

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From the existing data on the topography of the lava cave in the Reunion Island[1,2,3] and of the observation of the inner surface structure of the lava cave, two important lava characteristics, yield strength and surface tension, were estimated. As for the yield strength, by using a simple model of steady state flow in circular pipe for analysis based on Bingham characteristics of lava flow in the tube [4,5] and from the height and slope angle of the lava tube on the sloped region, the yield strength of the lava can be in the range from 5000 to 25000 dyne/cm^2 for the caves of low altitude, from 25000 to 75000 dyne/cm^2 for the cave of high altitude. These values are very near to the value of 2000~5000 dyne/cm^2 for Kilauea, and of 80000 dyne/cm^2 for Mauna Loa or 70000 dyne/cm^2 for Etna calculated by G.Hulme[6].

As for the surface tension, from the pitch of lava stalactites on the roof surface (3 to 4 cm) (see Photo-1,2), the surface tension of lava was determined as about 600 to 1000 dyne/cm by using a model based on the simple hydrodynamic instability model of gravity/surface tension acting on the melting liquid layer attached on the inner surface of the lava cave though there is a superposition of the lateral and vertical surface flow. Further detailed investigations and observations are undergoing.

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Photo-1. Roof of Tunnel of 2004 lava flow: La Blanche Nord

Photo-2. Side Wall of Tunnel of 2004 lava flow: La Blanche Nord

An assessment of the hazardous nature of atmospheres in lava tubes and caves

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To identify how hazardous an underground atmosphere is, it must be characterized and its source identified. The ideal way to do this is to dry and analyze it for the gases it contains. In many cases, oxygen and carbon dioxide analyses may be sufficient to identify the source. However, speleologists often only assess the hazardous nature of the underground atmosphere by measuring only the carbon dioxide (CO_2) content of the wet gas.

Type I Replacement of O_2 by CO_2: respiration and combustion.

Type II Addition of CO_2, dilution of O_2 and the residual fraction: examples are CO_2 evolution from water, anaerobic CO_2 production by microbes and volcanic emissions.

Type III O_2 depleted by other mechanisms than CO_2 dilution or production.

The type of cave atmosphere can be categorized by plotting the experimental values oxygen and carbon dioxide for dry air on a Gibbs Triangle (Figure 1).

Further information concerning the sources of the CO_2 in underground atmospheres can be obtained from ^{13}C studies. In the following paragraphs examples relevant to the volcano speleologists are discussed.

In lava tubes a Type 1atmosphere is the most likely to be encountered. Bayliss lava tube, Undara, McBride Volcanic Province, Queensland, Australia will be used as an example. The conditions in this lava tube are perfect for Type 1 continuous microbial CO_2 production. It is a warm, wet environment, with a nutrient supply brought in by floods and bats there are also tree roots. Figure 2 shows the CO_2 and oxygen levels throughout the cave. The CO_2 addition to O_2 reduction mole ratio is almost 1:1 clearly identifying it as Type I CO2 enrichment. Thus CO_2 measurements would be adequate to assess the hazard to explorers. Figure 2 shows that CO_2 and O_2 levels throughout Bayliss Cave and at the poorly ventilated end of the

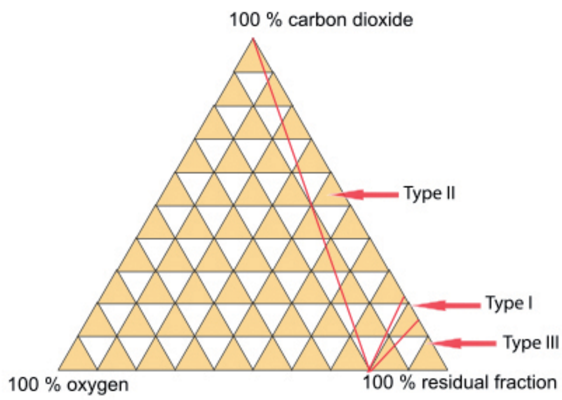

Figure 1: Gibbs triangle plotted for dry air using carbon dioxide and oxygen analyses. All other gases are included in the residual fraction.

cave CO_2 has been measured at 6 % and oxygen at 15 %. The danger a rising in from CO2 as high as this when associated with the equivalent fall in O_2 is poorly understood. Responses to such atmospheres can vary with physiological tolerance and personality the result is that explorers can put themselves at risk.

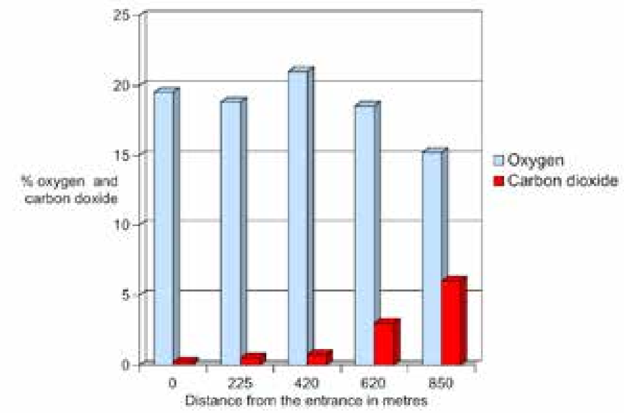

Figure 2: carbon dioxide and oxygen levels plotted against distance into Bayliss Cave

The Queensland National Parks Service requires that CO_2 concentrations be less than 0.5% and O_2 more than 19.5% measured in the Bayliss Cave entrance chamber for entry to the lava tube to be allowed. Access to Bayliss Cave is only granted for scientific purposes.

Type II CO_2 enrichment can lead to exceptionally high concentrations of the gas. The example used will be CO_2 production in the Zbrašov Aragonite Cave, Hranice Karst, Czech Republic (Figure 3). The warm mineral springs in the limestone cave are highly aggressive due to high concentrations of dissolved CO_2. CO_2 is released from the spring waters and forms gas lakes that are several meters thick. CO_2 is heavier than air and thus it remains close to its source until removed by ventilation or diffusion. Lethal CO_2 concentrations are found in the gas lakes and have caused death by asphyxiation. The cave is opened for tourism. The CO_2 along the tourist trails is maintained below 1% by ventilation. Geyser stalagmites are found in the cave and a hypothesis for their formation will be presented.

La Grotta del Cane is of historical importance and is the subject of many myths and stories. The 9 m long cave lies to the north west of Naples, Italy in the Phlegraean Fields, an area of extinct volcanoes. The cave is located in the southeastern rim of Agnano Crater and has been classed as a fumarole, a volcanic discharge of CO_2. The CO_2 rises from a shaft to form a shallow lake of about 30 cm of almost pure CO_2 dioxide on the cave floor. Animals and humans have been asphyxiated in the cave. The close proximity thermal springs and Stufe di Nerone (Nero's Oven) a cavity excavated in a tufa deposited from ancient hot springs. It still has hot springs and deadly vapors, which may indicate that the primary source of the CO_2 in La Grotta del Cane could be hydrothermal water.

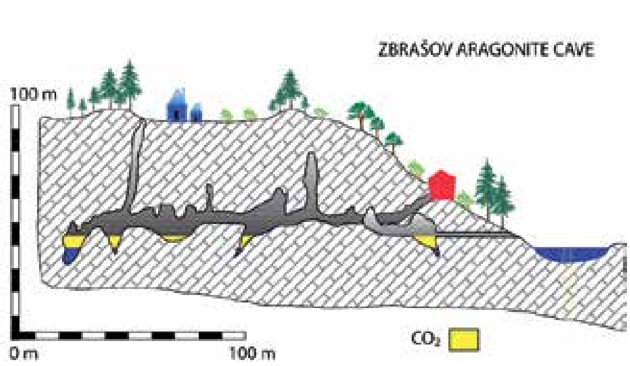

Figure 3: Carbon dioxide gas lakes in Zbrašov Aragonite Cave.

The examples that will be used in this paper are all in sites where volcanic activity is no longer present and hence lethal gas concentrations may not have been anticipated. The vulcanospeleologist should be aware that such sites the atmosphere in a lava tube or cave might be unsafe. By tradition, carbon dioxide is regarded as the gas to measure. However, it is lack of oxygen that kills and only indirectly is carbon dioxide implicated. An oxygen meter is the preferred instrument when exploring cavities in areas of past or present volcanic activity.

How can we get more geology from pyroduct (lava tube) exploration?

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Pyroducts (lava tubes, lava tunnels, lava conduits) are essential features of basaltic shield volcanoes. Nevertheless they do not play a prominent role in the volcanological literature and are mostly dealt with as a curiosity. The activity of the UIS Vulcanospeleological Commission and various symposia at the International Speleological Congresses or national conventions have, however, publicized them among the caving community and lava cave research has made major discoveries in the last 30 years. These discoveries and surveys are documented in a multitude of reports, descriptions, photo books and photo salons. But these are not normally referenced by "main-stream" volcanologists. Therefore the reason for the neglect of our results is not only the often heard notion, that "having seen one, is having seen them all", but also the lack of peer-reviewed publications, i.e., peer-reviewed outside of our community. Apparently our own community needs to step up and to provide more theory and interpretation of our findings that would catch the attention of the non-caving geologist. To my own surprise pyroducts and lava caves in general seem to be very varied in genesis (e.g,. Allred & Allred, 1997; Greeley et al., 1998; Kempe, 1997, 2002, 2009, 2012a,b; Kempe et al., 2010). For example in 2011, when working with the Bosteds in the lower reaches of the former Kahuku Ranch, we stumbled at a cave that for days kept us discussing how it formed: Kahuenaha Nui. It turned out to be a fourth model (Fig. 1b) (Bauer, 2011; Bauer et al., 2013) of how pyroducts come about apart from inflation (Fig. 1a) and the two kinds of the famous "crusting over of channels" mode (Fig. 1c, 1d).

The lesson is, that we all need to look closer at how caves form and how they develop in order to get overarching hypotheses. For example, what is the proportion of these four modi among pyroducts? Is the inflationary mode really in the majority (my impression)? And if so, is that only true for Hawaii, or do other regions show different proportions? Do we find pyroducts in volcanic rocks outside of the basalt window? So far only caves in picritic, tholeiitic and alkali basalts are well documented. Are lava falls only an occasional feature or do they form when caves have higher or lower slopes? How do slope and sinuosity relate? What is the importance of internal phreatic explosions for the erosive process? Is breakdown material coated as lava balls and swimming out of the cave or is it thermally resorbed?

These question could lead to a more general understanding of the processes involved and to a more geological approach to the phenomena encountered in lava caves. It is up to us to give these questions more room when surveying and reporting about caves: Detailed cross-sections of the lava flow itself where visible at places of breakdown could help; calculating slope, sinuosity, proportions of side passages, proportions of lava falls contributing to altitude change could help as well; just to name a few of the data that could be easily collected.

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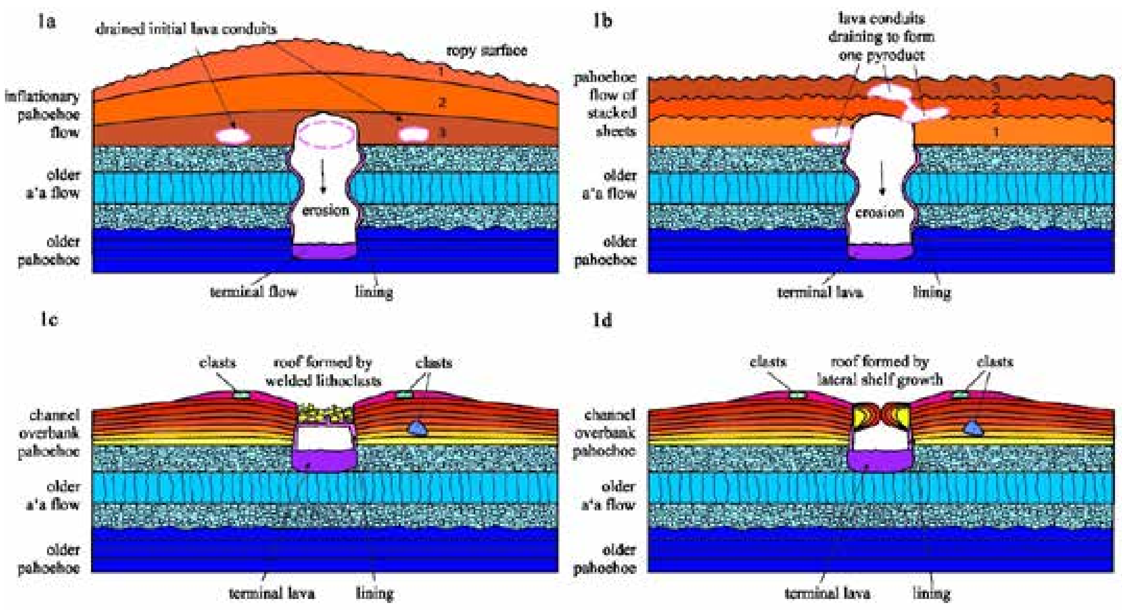

Fig. 1: Schematic cross-sections of the four as yet identified modi of pyroduct formation. The amount of erosion shown can be quite variable, even within the same pyroduct. Also, the underlying strata does not need to be an a'a flow necessarily. Cross-section 1a shows the inflationary mode where the roof sheets are oldest at the top and youngest at the bottom. There several ducts can develop in parallel that are drained once one of them cuts down, collecting all of the flowing lava into one bed. Cross-section 1b illustrates pyroduct formation by the collection of lava from several small conduits within lava sheets deposited on top of each other. Here the oldest lava sheet is at the bottom and the youngest on top. All flows converge and erode an underlying lava flow, preferentially an easily erodible layer of a'a rubble. Cases 1c and 1d illustrate the "crusting over of a channel". This can either happen by the jamming and welding of floating clasts (1c) or by the slow accretion of the side walls and closure across a channel along a central suture (Kempe, 2012a).

Planning a book on lava caves by the Vulcanospeleological Commission

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At the 1999 Vulcanospeleological Symposium at Catania, the idea of a book on lava caves was brought up by Paolo Forti. At the last day of the meeting I scribbled down a draft table of contents:

Table 1: Original List of Contents of a book on lava caves from 1999

Draft Concept (#1, 20.9.99, S. Kempe)

Vulcanospeleology, Exploring a Brand-New World

A) The Scope of Vulcanospeleology (20 pp.)

Lead author: W. R. Halliday

(Distribution of volcanogenic cavities, history of their exploration, vulcanospeleological symposia)

B) Speleogenesis (50 pp)

Lead authors: K. Allred, S. Kempe. C. Wood et al.

1) Lava tunnels, origin (inflationary flows, crusting over, branching etc., viscosity, petrology, a'a versus pahoehoe)

2) Lava tunnels and their internal structures and evolution (erosion, canyons, lava falls, pukas, secondary ceilings, cupolas, breakdown, plugs, ash fills etc.

3) Small scale structures (Linings, stalactites, stalagmites, runners, squeeze-ups, diagonal striation etc.)

4) Eruptive vents and fissures

5) Tree casts and associated cavities (authors T. Honda et al.)

C) Regional Vulcanospeleology **(**each 5 pp., total ca. 200 pp.**)**

Various authors

1. Overview: Hotspot Volcanism, Island Arc/volcanic plutonic arc, Mid-ocean Ridge Volcanism an their cave potential

2. Hawaiian Islands

2.1 Kilauea

Aila'au Flow Field (K. Allred, S. Kempe et al.)

South Flank (S. Kempe, C. Wood)

Caldera (W. R. Halliday)

2.2 Mauna Loa (D. &. H. Medville et al.)

2.3 Hualalai (S. Kempe, D. u. H. Medville et al.)

2.4 Mauna Kea (?)

2.5 Maui, Molokai, Kauai (W. R. Halliday)

3. Pacific Islands (B. Rogers)

(Easter Island, Galapagos, New Zealand)

4. Australia (J. Stephenson et al.)

5. Japan (T. Ogawa, T. Honda et al.)

6. South Corea (S.H. Hong et al.)

7. Indian Ocean (G. Middleton)
8. East Africa (R. Simons et al.)
9. Etna (G. Licitra et al.)
10. Europe (?) + Asia (?)
11. Island (S. Jonsson et al.)
12. Teneriffa (J.L.M. Esquivel et al.)
13. Azores (P.A.V.Borges et al.)
14. Mainland USA
    14.1 The Northwest (C. Larson et al.)
    14.2 The Southwest (G. Moore et al.)
15. South America (C. Banedetto)

D) Ten of the Most Interesting Lava Cavities (each 4 to 10 pp., total 80 pp.**)**

Various authors

1. Kazumura (K. Allred et al.)
2. Huehue (S. Kempe et al.)
3. Waipouli/Kamakalepo (S. Kempe)
4. Grotta del Fume, Macchia Gialla, Grotto dell'Arcosysten (G. Giudice et al.)
5. Profondo Nero/Etna (R. Bonaccorso et al.) or Fajanita Cave/La Palma (J.S. Socorro)
6. Cueva del Viento (J. L. M. Esquivel et al.)
7. Cueva del Verde/Atlantida (?)
8. Leviathan Cave (R. Simons)
9. Undara Cave System (J. Stephenson)
10. Cave on Cheju Island (?)

E) Mineralogy of Lava Caves (20 pp.) Lead author: P. Forti

F) Archeology of Lava Caves (?) (20 pp.) Lead author: B. Camara (?)

G) Planetary Scale of Volcanic Cavities (20 pp.) Lead author: R. Greeley

Total Pages: ca. 430 manuscript (in print ca. 300)

Time line: First have NSS consent for publication costs (plus others who might want to share like Italian, Spanish or German National Federations)

Then plan 3 years for contributions and 1 year for publication and production

Goal: 2005 (at Intern. Congress)

The list was shared with Paolo Forti and Bill Halliday. Paolo was pretty much tied up with the forthcoming Intern. Geol. Congress at Bologna in 2004 and Bill clearly stated that he wanted to finish his pseudokarst book first. I myself had also other plans and in the meantime coedited/coauthored three other books. Thus things were on hold until Chris Wood picked up the idea, thinking of a textbook to be published with Wiley or another British publisher. The untimely death of Chris canceled this plan as well so that we are back on the 1999 scheme. However, not only Chris died, but unfortunately also Ronald Greeley. Others listed initially lost interest in the topic whereas more potential contributors appeared on the scene. Bill Halliday is still working on the pseudokarst book so that he will not be a potential author.

The delay may actually turn out to be of advantage because meanwhile Jack Lockwood and Richard Hazlett have finished their volcanology text book (2010) that for the first time contains a longer section on pyroducts. Also biological research in lava caves has yielded marvelous results (e.g., Northup et al., 2012) and I had the chance to write a review chapter on volcanic rock caves in the new edition of Encyclopedia of Caves (Kempe, 2012), as well as a chapter on volcanic rock speleothems (Kempe, 2013).

Thus we need to discuss not only if such a volume should be pursued, but also its potential funding. Furthermore we need to check on the list of topics (a chapter on biology should be added), the list of the most important caves and, most obviously, identify those colleagues that would want to contribute to this effort.

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Detecting Lava Tubes With a Smart Phone?

Andy Lillington

This paper describes the methodology and subsequent field tests undertaken in July 2013 to try and detect the presence of a lava tube using the magnetometer inside an Android® smart phone.

Trials were undertaken at three different lava tubes in Iceland, which all produced similar and repeatable results. A comparison is then made to other research that was undertaken using professional surveying equipment, together with a direct comparison to precision 3-axes USB powered digital magnetometer.

The results demonstrate a reasonably close correlation, which suggests that it may be possible (in some circumstances) to roughly detect lava tubes using a smart phone in lieu of expensive surveying equipment.

This article follows on from the pilot trials which were undertaken in July 2012, as described in SMCC Journal series 13 no.1.

Background Research

The background to the concept of using a magnetometer to detect lava tubes from the surface was discussed in SMCC Journal series 13 no.1. The method has been around for some time and has been tested by others (using professional survey grade equipment) with some degree of success.

In addition to the review of scientific research which was undertaken in series 13 number 1, a joint attempt with Phil Collett identified a number of additional documents, which are summarised below.

Monument Cave, California

Surveys were undertaken in 2003 at Monument Cave in Lava Beds National Monument in California, which included the use of a high sensitivity magnetometeri. Data was collected at a sampling rate of 10Hz using a Geometrics G-858 caesium vapour magnetometerii: a fast-sampling 'walking' magnetometer that is sensitive to 0.03 nT at a 0.2 second sample rate.

At Monument Cave, the recorded passage width was 12 metres, with a height of 5.4 metres and an overburden of 5.4 metres. The orientation of the lava tube was NE-SW and the traverse line was orientated approximately north-south along an asphalt road. This research also successfully detected the known lava tube, with a total field anomaly of about 1.2µT.

The researchers at Monument Cave also considered some reasons for magnetic anomalies caused by lava tubes. The researchers believe that a magnetometer detects a total field which is a summation of anomalous fields and the background field effect of the Earth on susceptible materials.

Anomalous fields include remanant magnetisation which is understood to be a magnetic field which becomes "locked" into the iron-titanium oxide minerals in basalt at the time that the lava cooled. This is known as thermo-remanant magnetisation (TRM). Where there is a void, then there would be a reduction in the anomalous field. Depending on the orientation of the remanant magnetisation, and the orientation of the present day magnetic field, the researchers at Monument Cave considered that a void could appear as a high or low in the total field data.

The magnetic data collected at Monument Cave was compared to a software-derived model, and the "best fit" of the data was obtained by reversing the current day magnetic field inclination (or "magnetic dip" towards the poles inside the earth). This produced a magnetic "high" to the northwest of the tube, rather than to the southeast.

A magnetic "high" to the south might be expected with a lava tube in the northern hemisphere (i.e. needles on a compass follow the Earth's magnetic lines of force, so will point downwards north of the magnetic equator).

It was therefore considered that the basalt in Lava Beds National Monument may have cooled at a time when the Earth's magnetic field was different, and the remnant magnetisation was "locked" into the minerals (this is also known as Palaeomagnetism).

Figure 14 in the Lava Beds report shows a negative inverted dipole type anomaly orientated to the northwest. However, this was a model created to fit the data, and not the data itself.

Bear Trap Cave, Idaho

In America, magnetic traverse tests were undertaken over Bear Trap Cave in Idaho in 2002 with a proton precession magnetometer accurate to 0.2 nT together with GPS rover data collection tied to a benchmarkiii. The tests successfully detected the known lava tube and demonstrated a negative total field anomaly of about 2-3 µT magnitude from several traverses of the known lava tube.

Software-based models were also used in the assessment to try and match the observed data, with adjustments made to the remanent magnetic inclination and declination based on the age of the basalt flows from borehole data. The software calculated an inverted dipole anomaly over a NS orientated lava tube, with equal height flanks either side of a low point in the centre of the lava tube.

However, for an E-W direction lava tube the inverted dipole anomaly changed such that the northern flank became greater than the southern flank and the low point was shifted to the south of the lava tube.

The paper also calculated a model of the Bear Trap Cave on a NE-SW direction which showed a profile somewhere between the two. Thus the shape of an anomaly would seem to depend on the orientation of the tube in relation to the inclination and declination of the Earth's magnetic field at the time of creation.

The observed magnetic profiles obtained from the series of traverses (undertaken orthogonally to the direction of the lava tube) also demonstrated an inverted dipole anomaly, but not a direct match to the models; this difference was considered to be related to other geological features.

Mount Etna, Italy

In July 1992, two magnetic field traverse surveys spaced 15 metres apart were undertaken on an active flow during an eruption at Mount Etna in Italy. A paper was presented in the Journal of Volcanology in 1995iv, which describes the findings from this research.

The traverses were undertaken fairly close to a lava tube skylight and repeated over a timeframe to follow the variations in magnetic field as the lava field cooled. A Geometrics G856 caesium vapour Magnetometer was also used for this survey work. The traverse lines in this were orientated north-south and the lava tube was orientated east–west.

The research on Mount Etna revealed an inverted dipolar anomaly in the total magnetic field of 4 μT on each 80m traverse; corresponding to a lava tube beneath the cooled surface. Figure 5 in the paper shows the collected data together, with a theoretical thermo-magnetic model of a lava tube overlying this data, which can be seen to almost match the observed magnetic anomaly.

The paper provides further insights about magnetism in lava flows and considers that TRM in basaltic rocks can have an intensity of 1-2 orders of magnitude greater than the intensity of induced magnetism of the surrounding rocks. That is to say, the effects on the magnetometer reading would be heavily influenced by the "locked in" historical magnetism of the basalt rocks.

Given the Italian survey was undertaken on an active flow i.e. just being formed (locking in the current field of the Earth) it is curious to note that the magnetic high occurred on the north side of the lava tube and not on the south side, as might be expected with the approximate SSW-NNE orientation.

This finding seems at odds with the American research, and it is not entirely clear what the reason is for this apparent contradiction.

Methodology

Phil Collett's novel idea was to utilise the miniature chip based magnetometer inside a smart phone to simultaneously record xyz magnetic field strengths, at the same time as GPS location. However, this idea needed testing, so a limited series of trials were undertaken in Iceland during July and August 2012 to see if this was a realistic possibility.

The pilot tests demonstrated some unusual pulsed readings, which was eventually traced back to electromagnetic (EM) interference from the GPS chip inside the phone. Unfortunately this also served to obscure most of the magnetometer readings taken.

However, at Raufarhólshellir lava tube, probably due to the size of the lava tube, there were some tantalising results. There were some anomalies in the total magnetic field which were sufficient to appear through the EM noise generated by the GPS sensor chip.

Therefore, in July 2013 a return trip was undertaken to Iceland to repeat the tests with the GPS in the phone switched off. A separate GPS unit was used to record the start and end locations of each traverse over the lava tube. The objective of the tests undertaken in July 2013 was to try and prove (or disprove) the concept of using a smart phone to detect lava tubes.

To attempt inclusion of an element of control into the experimentation, and help rule out any interference (which might produce erroneous and misleading results), the new series of field trials included repeated traverses, and surveys, at a number of different lava tubes.

Three different lava tubes were selected for the tests and the traverses were repeated over the same line in both directions. A small cairn was built to mark the start and end of each traverse line and the location of these cairns was way-pointed using a GPS/GLONASS Etrex30 unit.

A Samsung Galaxy S2 phone was operated in 'flight mode' with the GPS and all other unnecessary applications switched off.

Each traverse was undertaken at walking speed holding the phone relative to the body at about waist height, and as level as possible, to help avoid any issues with false readings from the geosensors.

All items of potential interference were also taken out of pockets and a metal wrist watch removed. Before each traverse, the phone sensor was calibrated by rotating on each xyz axis.

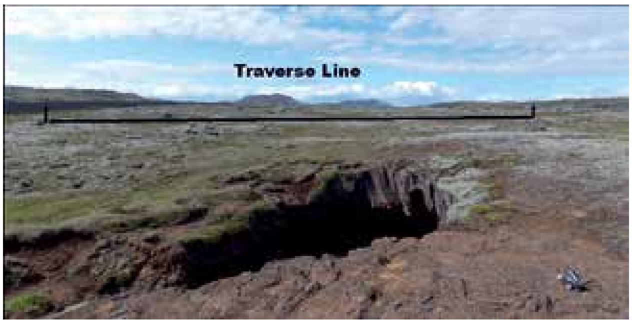
The Android application "Androsensor" version 1.9.4.4v was used to help record the xyz magnetic field, with the recording interval set to 0.2 seconds. The screen brightness was also limited to minimise any soft iron effects on the magnetometer chip.

Field Trials

Site 1 : Raufarhólshellir

Raufarhólshellir lava tube is located adjacent to the No.39 þrengslavegur Road to the south west of Reykjavik. This lava tube is typically about 8-10m in diameter with varying thicknesses of overburden. The overburden is perhaps about 5 metres in depth.

A traverse line was selected "up flow" of the last skylight, at a distance of 25 metres, to try and avoid any localised anomalies associated with lightning strikes. Photograph 1 illustrates the traverse line of the survey.



Photograph 1 – Traverse Line above Raufarhólshellir Lava Tube

The GPS waypoints for each end of the traverse line were downloaded from the GPS unit and imported to Google Earth. The original SMCC 1970 survey was then overlaid, and scaled, to determine the location and angle of the lava tube versus the traverse line. Figure 1 provides an illustration; MAGR1 and MAGR2 denote the start and end waypoints of the traverse. It can be seen that the lava tube is orientated approximately NW-SE, and the traverse line crosses the lava tube perpendicularly. The length of the traverse line was approximately 65 metres.

Figure 1 - Plan View of SMCC Raufarhólshellir Survey and Traverse Line

A total of four traverses were undertaken, two in each direction and an average was taken of the data collected. The phone sensors were calibrated before each traverse using the "Figure of 8" method. A summary graph of the east to west traverse recorded by the Androsensor App (processed with Excel) is shown in Figure 2. The west to east traverse is shown in Figure 3.

Figure 2 illustrates a negative total magnetic field anomaly of approximately 4μT which is "mirrored" on the return traverses shown in Figure 3. Both figures demonstrate some variation between each of the repeated traverses, but the difference does not seem to be significant enough to obscure the same overall patterns, which are in recurrence.

Site 2 : Tagli Lava Tube Tagli Lava tube is located in Northeast Iceland. This lava tube was the subject of the previous magnetometer trials in July 2012. For the second test, a similar traverse line was set up about 12 metres to the north east of the last skylight and directly crossing above the lava tube, which is approximately 7 metres wide and 3 metres high. The overburden was perhaps about 2-3 metres.

Tagli lava tube is also orientated approximately NE-SW and so the traverse line was orientated approximately perpendicular to the lava tube. Photograph 2 illustrates the traverse line of the survey, which was approximately 28 metres in length.

A total of six traverses were undertaken, three in each direction and an average was taken of the data collected. The phone sensors were also calibrated before each traverse using the "Figure of 8" method. A summary graph of the east to west traverse recorded by the Androsensor App is shown in Figure 4. The west to east traverse is shown in Figure 5.

Figure 4 illustrates a negative total magnetic field anomaly of approximately 3 μT that again is "mirrored" on the return traverses shown in Figure 5. This survey also demonstrates variation between each of the repeated traverses but not of a significant nature.

Site 3: Unnamed Lava Tube

The final test site was at an un-named lava tube, also located in Northeast Iceland. A traverse was set up such that the line was located about 20 metres to the south of the entrance and directly crossing over the lava tube, which in this location was approximately 5 metres wide and 3 metres high, with an overburden of about 2 metres. The lava tube is orientated approximately NE-SW and the traverse line crosses the lava tube perpendicularly. The length of the traverse line was approximately 27 metres. A total of four traverses were undertaken, two in each direction, and an average was taken of the data collected. The phone sensors were also calibrated before each traverse using the "Figure of 8" method. A summary graph of the east to west traverse recorded by the Androsensor App is shown in Figure 6. The west to east traverse is shown in Figure 7.

Figure 6 illustrates a negative total magnetic field anomaly of approximately 3 μT which that again is "mirrored" on the return traverses shown in Figure 7. This survey also demonstrates variation between each of the repeated traverses, but not of a significant nature.

Site 4 : Comparison to USB powered digital magnetometer in UK

A direct comparison of the galaxy phone with a USB powered 3 axes digital magnetometer was undertaken in the UK during early 2014. The Oak Orient USB powered Sensor[vi] was produced by Toradex as an integrated low cost (£25) precision accelerometer and magnetometer with a female mini-B USB connection port. The Oak sensor is capable of recording real time data with a sampling rate of between 1ms and 65 seconds and a resolution of 8 milligauss (0.8 μT). The typical power consumption of the sensor during data logging is about ¼ watt.

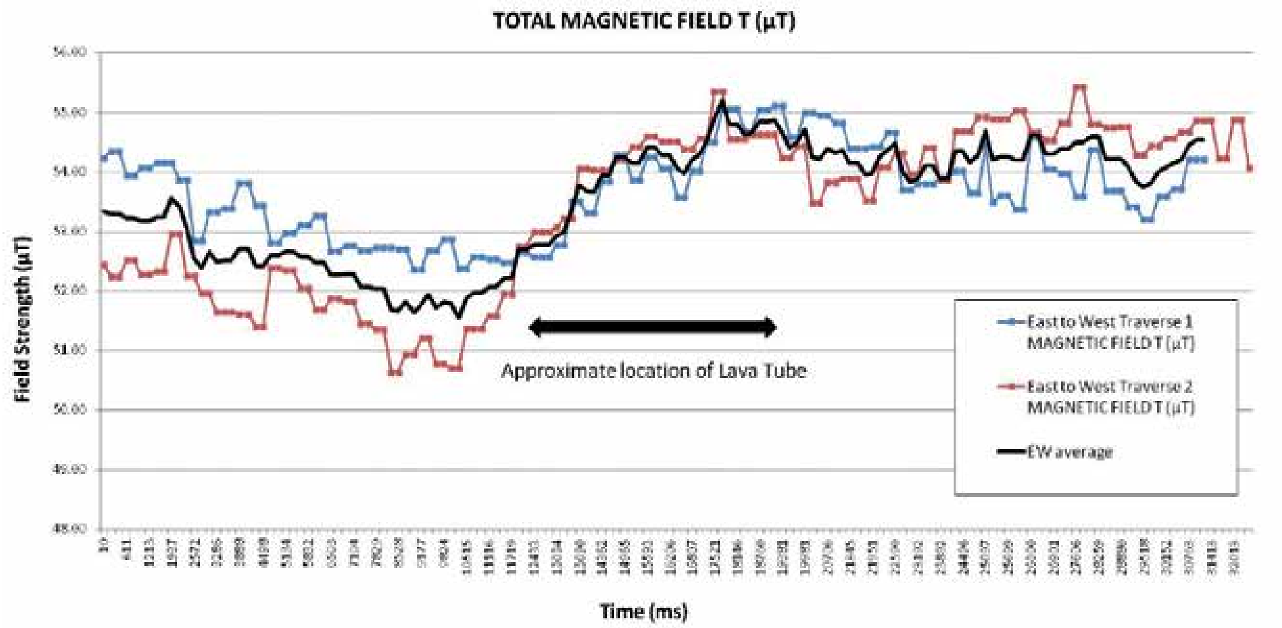


Figure 2 - Total Magnetic Field on East to West Traverse Line above Raufarhólshellir

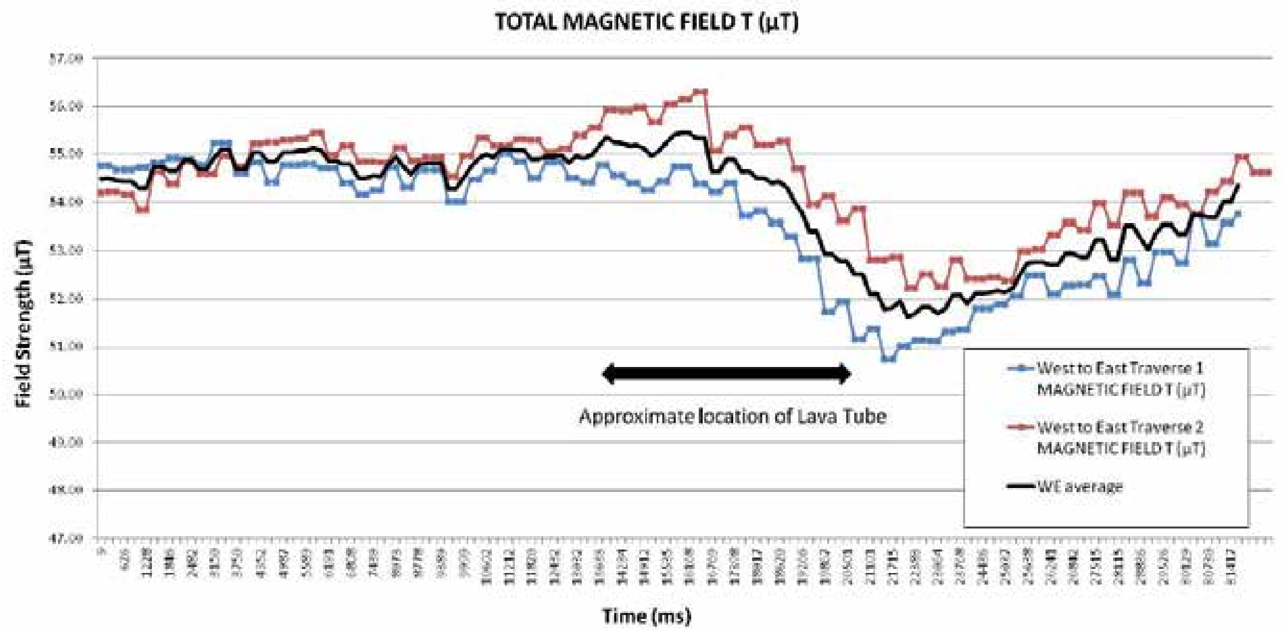


Figure 3 - Total Magnetic Field on West to East Traverse Line above Raufarhólshellir

Toradex offer a simple windows based software application to process the data from the Oak device and this was used with a Windows® XP notebook to undertake a direct comparison to the Samsung Galaxy S2 phone. A Windows® based tablet could equally be used. The device is illustrated in Photograph 3.

For this test, a substantial iron bar was placed on the ground and proximity traverses were made to/from a height of about 100cm to 5cm, keeping the sensor orientation as level as possible. A control test was also undertaken without the iron bar which demonstrated no discernible changes in total magnetic field on the traverse. The survey results are presented in Figure 8.

The summary results presented in Figure reveal that a total field magnetic anomaly was detected in the close vicinity of the iron bar of about 20 µT.

Discussion of Results

The field trials undertaken at each of the three lava tubes in Iceland have all demonstrated a total negative magnetic field anomaly of about 3 µT, which was repeatable over multiple traverses.

Photograph 2 – Traverse Line above Tagli Lava Tube

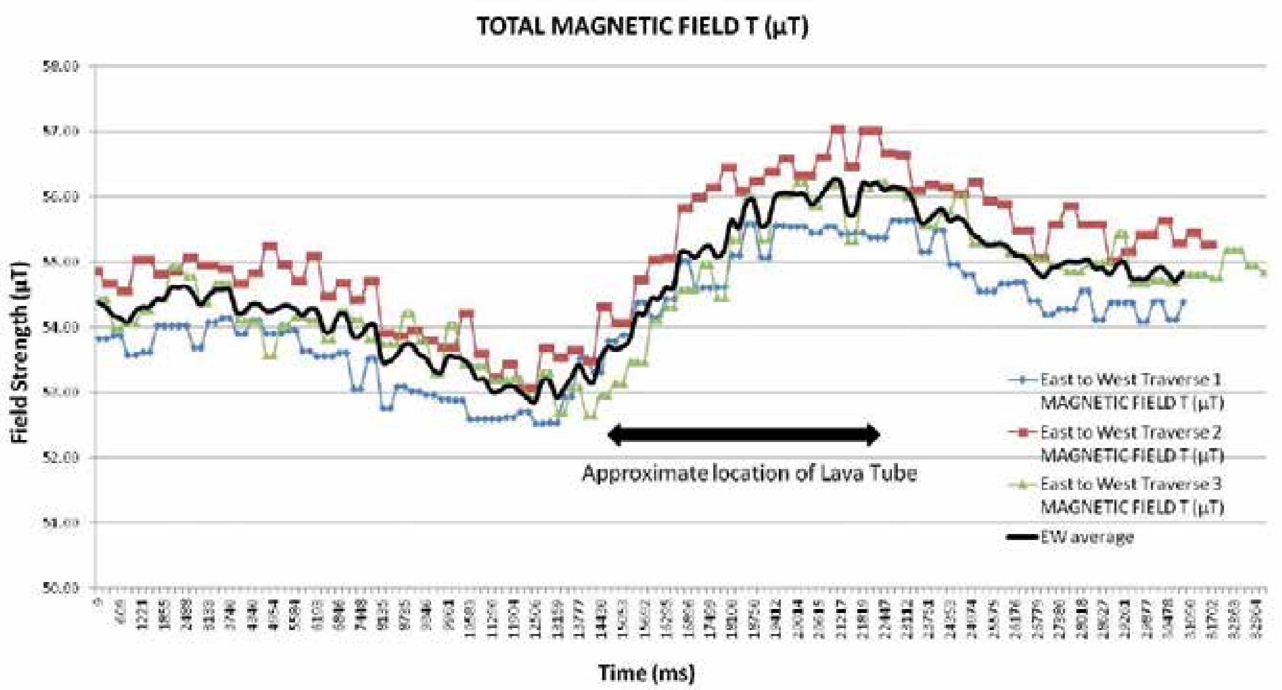


Figure 4 - Total Magnetic Field on East to West Traverse Line above Tagli

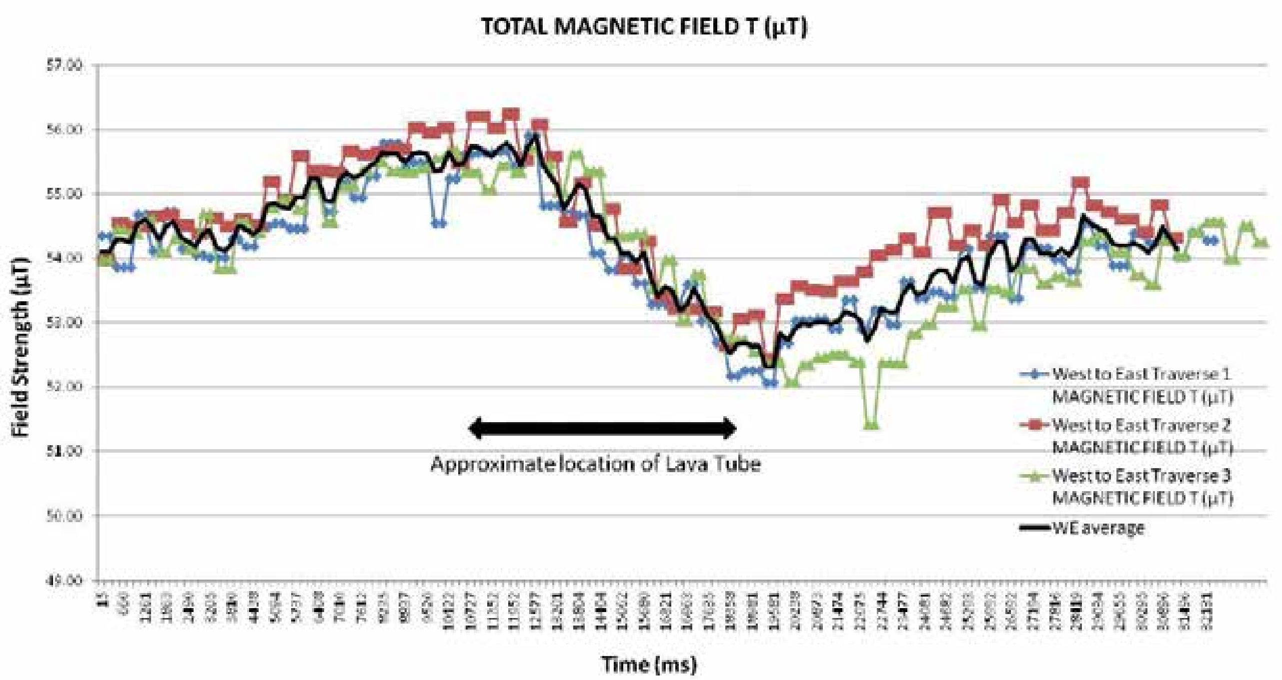


Figure 5 - Total Magnetic Field on West to East Traverse Line above Tagli

The summary data in Figures 2-6 illustrate some variability between the repeated traverse lines but not at a level which gives rise to any confusion in the total field anomalies. These variations might be expected, given a smart phone is not a calibrated precision instrument, and undoubtedly there is software processing of the raw data from the magnetometer chip, which may also feed in data from other sensors in the phone. The very act of walking on uneven lava may be one of the reasons for the observed variability between the trace lines.

The survey data has not been corrected for any time perturbations or daily diurnal variations of the Earth's magnetic field. These are understood to occur from ionisation of the upper atmosphere by solar radiation, in relation to tidal effects between the Earth and Moonvii. These are typically of the order of 20-80 nanoTesla. Magnetic storms can exceed 1 µT, but normally over a period of 24 hours - these tend to affect latitudes close to the poles. As the traverses in Iceland were undertaken in quick succession, it was considered that the amplitude / time period of any corrections should not materially affect the collected survey results.

The shape of the total field anomaly in all three surveys is very similar, and forms a negative "dip" on the "east" side with a positive "peak" located on the "west" side of each lava tube. At all three sites, the orientation of the lava tube was either NE-SW or NW-SE and the traverse line was approximately orthogonal to each tube passage.

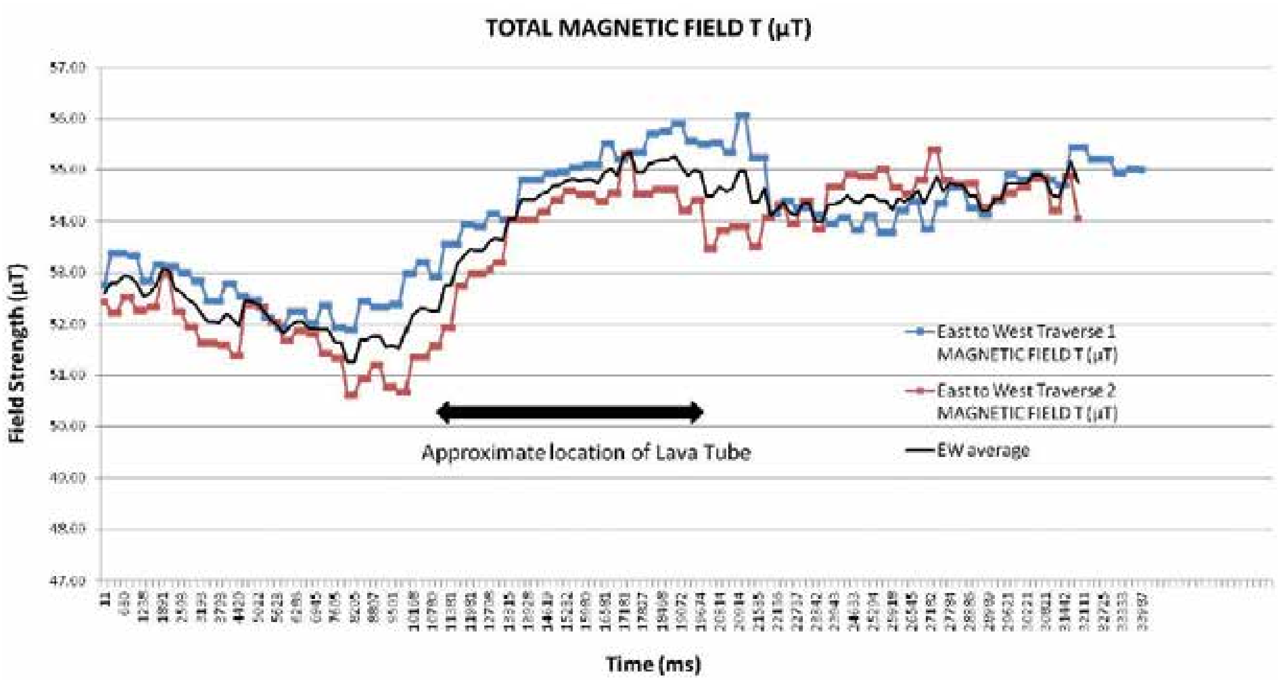


Figure 6 - Total Magnetic Field on East to West Traverse Line above Un-named Lava Tube

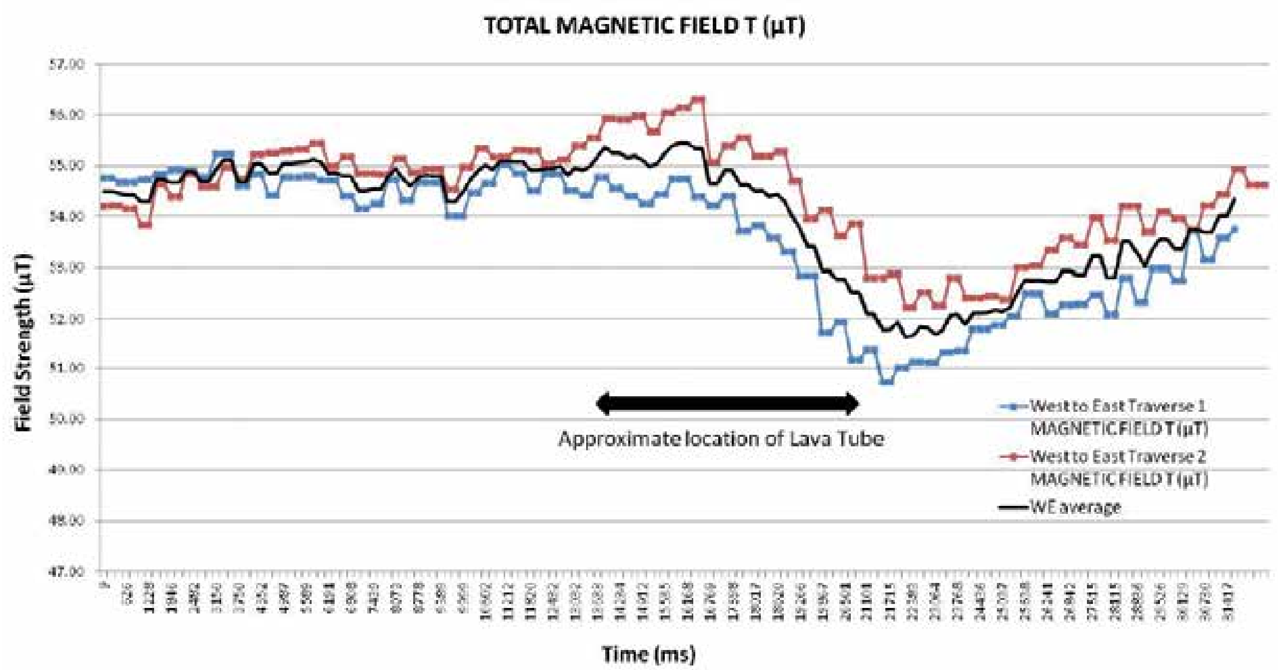


Figure 7 - Total Magnetic Field on West to East Traverse Line above Un-named Lava Tube

The shape of the anomaly was unexpectedly different to the anticipated "double bump" as the traverse line passed over the edge of each lava tube as described in SMCC Journal series 13 no.1. The original assumption was based on the concept that there might be a concentration of induced magnetic field lines on the edges of a lava tube leading to the creation of two anomalies.

Summary of Total Field Anomalies

A comparison of the three magnetic surveys undertaken in Iceland in 2013 is provided in Figure 9, using an average of all the traverse lines undertaken at each site.

Figure 9 illustrate a similarity in total field magnetic anomalies recorded over the three lava tubes.

Photograph 3 – Toradex Oak Orient Magnetometer connected to Notebook

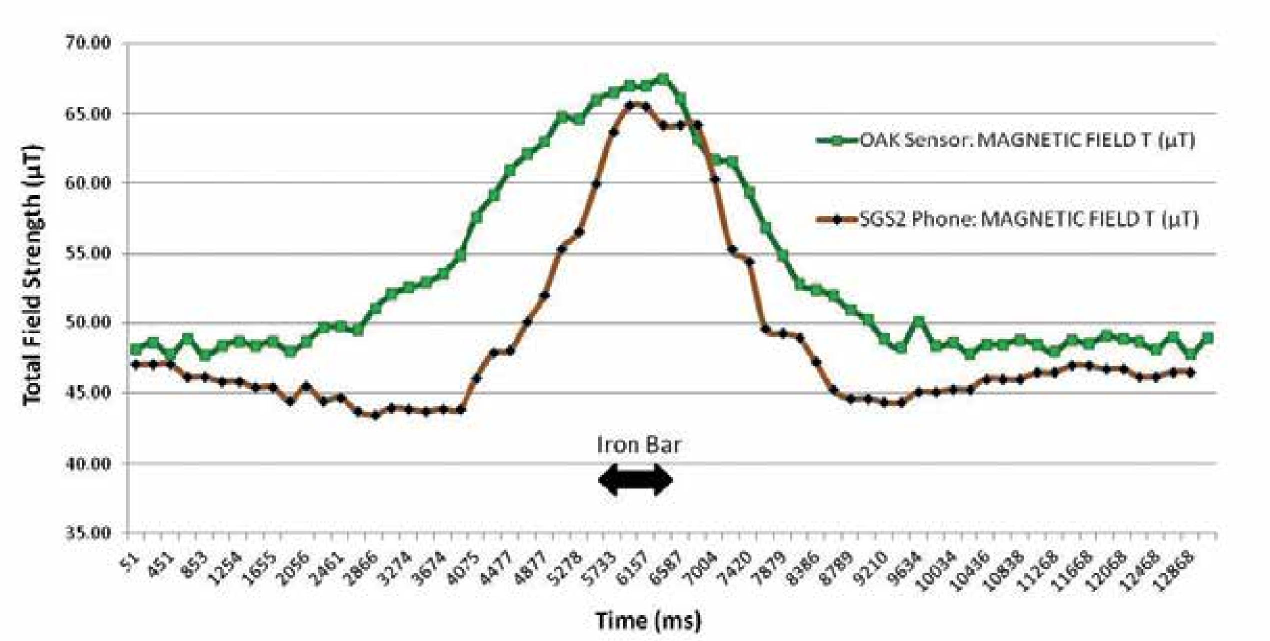


Figure 8 - Direct Comparison of Phone with External Digital Magnetometer

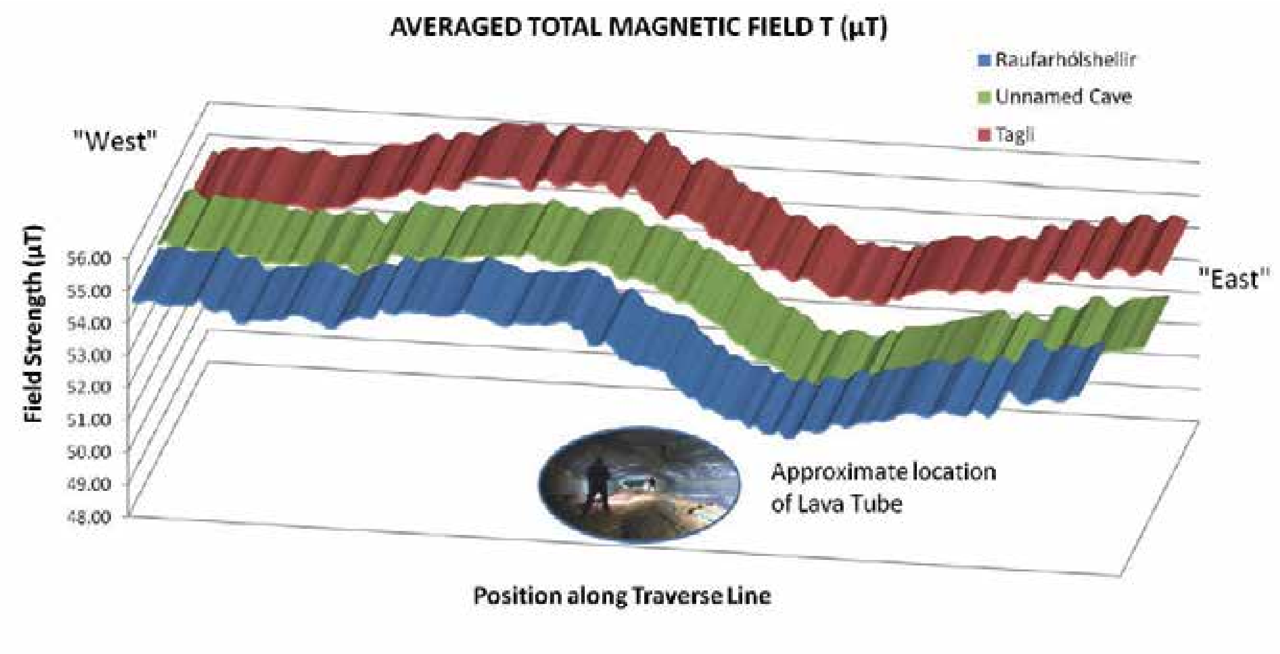


Figure 9 – Comparison of Magnetic Surveys in Iceland

The different total field magnetic anomalies obtained from the American and Italian research are summarised and then compared to the 2013 Iceland surveys in Figure 10.

Figure 10 illustrates there is similarity in the shape of the total field magnetic anomalies recorded over the three lava tubes, with a comparable amplitude.

The summary results presented in Figure 8 comparing the phone to the external digital magnetometer sensor suggest that both the phone and the Oak sensor detected the iron bar with a similar recorded magnitude of a magnetic anomaly.

Conclusions

This paper has described the use of an Android® based smart phone to try and detect and log the presence of a lava tube using nothing more than the internal magnetoresistance sensors.

This research offers some tantalising evidence to suggest that a Samsung Galaxy S2 phone was able to sense (but not ensure) the presence of a void emptied lava tube. The amplitude and shape of the recorded total magnetic field anomalies appears to be commensurate with other research conducted over lava tubes using high sensitivity professional survey grade caesium vapour equipment. However, given the lower sensitivity of the microelectronics in the phone, the detection appears to be relatively coarse.

Cave	Bear Trap Cave, Idaho (2002)	Monument Cave, California, (2003)	Etna Lava flows, Italy, (1992)	Raufarhólshellir, Iceland (2013)	Tagli, Iceland (2013)	Un-named Tube, Iceland, (2013)
Orientation of cave passage						
Direction of magnetic traverse	1 2	1 2	1 2	1 2	1 2	1 2
Shape of magnetic profile recorded	1 2	1 2	1 2	1 2	1 2	1 2
Amplitude of magnetic anomaly	2-3 µT	1.2 µT	4 µT	4 µT	3 µT	3-4 µT

Figure 10 - Comparison of Total Field Anomalies

The direct comparison test of the phone with an external digital magnetometer sensor was successful in so far as it was repeatable and the recorded magnetic anomaly was similar in size and amplitude.

The tests also imply that the internal electromagnetic "noise" level produced inside the phone can be successfully minimised to avoid obscuration of data from the magnetoresistance sensor, by operating the phone in flight mode with GPS switched off. It was also determined that the phone should be calibrated before each traverse, and held level as possible, with no other sources of interference.

However, it should be noted these tests have only been properly undertaken with one make and model of phone (Samsung Galaxy S2). A pilot trial was undertaken with an Apple® iPhone but this was not successful, as the phone was not tested in flight mode with GPS isolated. Therefore it is currently unknown if the technique and application would work as well with other phone models.

A magnetic anomaly suggesting the presence of a lava tube often seems to form a negative inverted dipole of about 3-4 µT magnitude in the total magnetic field. Many researchers seem to consider that the anomaly is likely to be mostly caused by the "locked in" magnetic field of the basalt and the void space causing a localised reduction in the field strength, rather than concentration of the induced magnetic field lines around the lava tube created by the Earth. Another theory is that the difference in magnetic permeability between the lava and the void space may create the anomaly.

Therefore the ultimate shape of the anomaly would appear to be dependent on many factors which could include, amongst other things:

• The age of the lava, in terms of the palaeomagnetism of the rocks (i.e. the thermoremanant magnetisation which locks in the inclination and declination of the magnetic field when the lava flow was formed);

• The level of magnetic susceptibility of the basalt in the vicinity of the lava tube;

• The orientation of the lava tube in relation to the inclination and declination of the Earth's magnetic field;

• Anomalous pockets of mineralisation and other oxidation reactions after cooling; and

• The depth of the overburden, the thickness of any loose material, and any layering of the lava to affect the amplitude of the anomaly.

The trials at three sites in Iceland have revealed that the orientation of the total field anomalies is similar to the observations in the USA. That is to say, the orientations of the anomalies do not appear to follow the current inclination and declination of the Earth's magnetic field.

This reasoning suggests that the orientation of the Earth's field may have been different when the lava flow cooled in Iceland, and perhaps supports the theory that the predominant method of detection of anomalies in basalt is through reduced thermoremanant magnetisation over the void space.

A Google Earth based animated model of the global geomagnetic field from the present day to 5000 B.C.

can be downloaded from the EarthRef Digital Archive ERDAviii which is based on research undertaken in 2005 ix. This data suggests that the declination for example at about 2500 B.C. in Iceland was +13 degrees west. It is currently about -14.7 degrees west over Raufarhólshellir lava tube. Hence the historical magnetic field may have been significantly different when the lava tube formed; perhaps 25-30 degrees. Given the orientation of the lava tube on a NW-SE orientation, a change of this magnitude may have been sufficient to cause the observed shift in the shape of the anomaly, as a result of the historical inclination and declination of the Earth's magnetic field at the time of creation of the lava tube.

The next step of the application will be to try to detect unknown, postulated cave passage and perhaps to help direct any digging operations. Also, custom software programming is sought to allow the external Oak magnetometer to be plugged into the USB "B" type connection on an Android® phone to allow the GPS to record log data concurrently with the external magnetometer. The author would be grateful for any assistance with this project.

A further test will hopefully be carried out in the future to directly compare a phone with caesium vapour survey-grade equipment as suggested by a colleague, Antony Butcher.

Acknowledgements

The Author would like to thank Phil Collett for assistance in researching for documents and

providing guidance, advice, and review of this article. Also Antony Butcher for review of this article and providing suggestions about future testing of the phone against survey grade equipment.

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The 15th International Symposium on Vulcanospeleology Hashemite Kingdom of Jordan in March 2012

Harry Marinakis

U.I.S. Commission on Volcanic Caves

The 15th International Symposium on Vulcanospeleology was held at Hashemite University in the city of Jarka, in the Hashemite Kingdom of Jordan, from March 15 through March 18, 2012. The symposium was chaired by Professor Ahmad Al-Malabeh, Ph.D., and co-chaired by Engineer Ali Al-Husban. Approximately 20 people participated in the symposium, representing the countries of Australia, Belgium, Germany, Iraq, Jordan, Netherlands, Switzerland, and the United States of America. During the symposium, the participants presented numerous papers, including an obituary of the late Dr. Chris Wood. The participants traveled to northern Jordan for an underground field trip to explore the 2,000-year old Yarmouk-Decapolis Aqueduct Tunnels, and later that day they visited the ancient town of Umm Qais on a mountain overlooking the Sea of Galilee.

The post-symposium field trip was held in eastern Jordan in the town of As Safawi in the Harrat Al-Shaam (Al-Shaam Volcanic Field), from March 19 through March 22, 2014. The Harrat Al-Shaam is also known as the "Black Desert." The base of the post-symposium field trip was at the facility of the Jordan Badia Research and Development Program, directed by Professor Odeh Al-Meshan, Ph.D. During this field trip the participants explored numerous lava caves throughout the Harrat Al-Shaam, and visited several archeological sites. These sites included desert "kites" (Neolithic gazelle traps), the bronze age city of Jawa on the Syrian border, and the 3rd Century Roman castle of Burqu on the edge of the Harrat.

Participants also traveled throughout Jordan before and after the symposium to enjoy the wonderful sights that Jordan has to offer. These sites include the ancient city of Petra, the Dead Sea, and the sandstone towers of the Wadi Rum.

The purpose of this presentation was to summarize, in photos, the outstanding people and events that made the 15th International Symposium of Vulcanospeleology such a success.

A brief illustrated introduction to early lava cave exploration in Iceland

Martin Mills

(Shepton Mallet Caving Club and Grampian Speleological Group) and Christine (Kirsty) Mills (Grampian Speleological Group.

From the settlement of Iceland around 870AD to the present day, with particular reference to the expeditions of Banks and Von Troil in 1772, Paul Gaimard in 1835/6 and the many subsequent 19th Century "explorers" and their illustrations of the caves.

A short report about Cave and Cavern Diving in Ecuador mainland and the Galapagos Islands

Jorge A. MAHAUAD

Galapagos Tip Top Diving

Cave and cavern diving are completely undeveloped underwater activities in Ecuador and the Galapagos Islands.

Although there are several karstic caves in the sub-andean regions of Ecuador mainland, the cave systems start at relatively high elevations and the formation of waterfalls and speed at which water runs inside prevents caves from flooding.

There are vast limestone areas with solution caves deeper in the jungle region (and therefore with potential for permanently or seasonal flooded sections and sumps); however, most of these areas remain unexplored due to their remoteness and difficulty of access.

In the Galapagos Islands cave and cavern diving are not developed either.

Some underwater grottos and cavern like formations created by basaltic rock movement and layering of lava flows have been identified underwater by local divers in the areas of Santa Cruz, Santiago, Floreana, Santa Fe and Hood Islands.

Ocean level lava tubes with diameters sufficient to fit a diver are rare in Galapagos but some can be found in Isabela Island. Isabela and Fernandina also present flooded collapsed lava tubes in coastal areas that can be explored as 'volcanic sink holes' but acquiring access to deeper areas of the structure is impossible due to the tightness of the lava structures. Similar structures can also be found in young coastal lava flows of Santa Cruz and Santiago Islands.

Some smaller and softer volcanic tuff cones (generally islets like Daphne minor) and the Northern Islands of Wolf and Darwin present erosion caves at sea level. Several of these erosion caves have shallow areas of cavern environments below sea level. These areas are often a refuge for underwater fauna.

Protection and Management of the Mt Suswa Lava Caves, Kenya: an update

Greg Middleton & Jim Simons

The lava caves of Kenya's Mt Suswa have been documented and studied since the mid-1960s but have only recently, following years of promotion and advocacy by Jim Simons and the Cave Exploration Group of East Africa, been brought under local management. Plans have been prepared and a start made on basic infrastructure and guided cave tours. Funding and further expert guidance will be required to enable the conservation and tourism potentials of this outstanding volcanic site to be realised.

Animal Life in Lava Tubes of the Galápagos Islands

[1]Steven J. Taylor, [2]Theofilos Toulkeridis, [3]Aaron Addison, [4]JoAnn Jacoby, [5]Rick Toomey, [6]Mick Sutton, [7]Geoff Hoese

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The cave fauna of the lava tubes of the Galápagos Islands has been studied primarily by Stewart Peck, with isolated descriptions of new species by other authors. Our biological studies build on this foundation, and complement current lava tube mapping efforts. Based on literature review and our work on Isabella and Santa Cruz, the diversity of cave life in the Galápagos Islands is briefly reviewed, with an emphasis on commonly encountered species and with consideration of factors influencing abundance and distribution of animals in caves.

Geodynamic and volcanic origin of lava caves in the Galápagos

[1]Theofilos Toulkeridis, [2]Aaron Addison

[1]Universidad de las Fuerzas Armadas ESPE, Ecuador - [2]Cave Research Foundation.

At first view, the active volcanoes of the Galapagos are not located near the plate boundaries of the Earth's shifting crusts where the great majority of the world's earthquakes and active volcanoes occur. More than 1000 km away from the closest subduction zone and a few hundred km from the nearest Mid Ocean Ridge, somewhere in the Pacific Ocean the presence of these volcanic islands at Galapagos offer a very different geodynamic setting and origin, much like the Hawaiian Islands. Therefore, some four decades ago, an explanation named the "Hot Spot" hypothesis came along and quickly became, widely accepted because it corresponds well with much of the scientific data obtained all around the globe in general, and the Galapagos Islands in particular.

A "Hot Spot" is a region of intense heat within the Earth's mantle. This hypothesis or theory, however, states that there is a "mantle plume" of intense heat that is relatively stationary and deforms the oceanic or continental crust or plate above it. These crusts or plates ride over the "long-living" Hot Spot and are occasionally perforated by the molten rock that rises from the earth's mantle. The crust or plate above the stationary mantle plume is forced upward by the heat, and subsequently volcanoes are formed (Fig. 1).

In the case of an oceanic plate above of a mantle plume, volcanic islands are formed (of course after having active submarine volcanism first). Therefore, with ongoing activity, the previously formed islands then move slowly away from the hot spot, making room for new islands to be formed by further volcanic activity. The older volcanoes eventually become inactive and slowly erode into the ocean depths resulting finally to linear volcanic chains many thousands of kilometers long. According to this theory, the distinctive linear shape of the Galapagos-Carnegie Ridge Chain reflects the progressive movement of the Nazca Plate over a deep immobile hot spot (Fig. 2). This hot spot partly melted the region just below the overriding Nazca Plate, producing small, isolated blobs of magma. Less dense than the surrounding solid rock, the magma rose buoyantly through structurally weak zones and ultimately erupted as lava onto the ocean floor to form volcanoes.

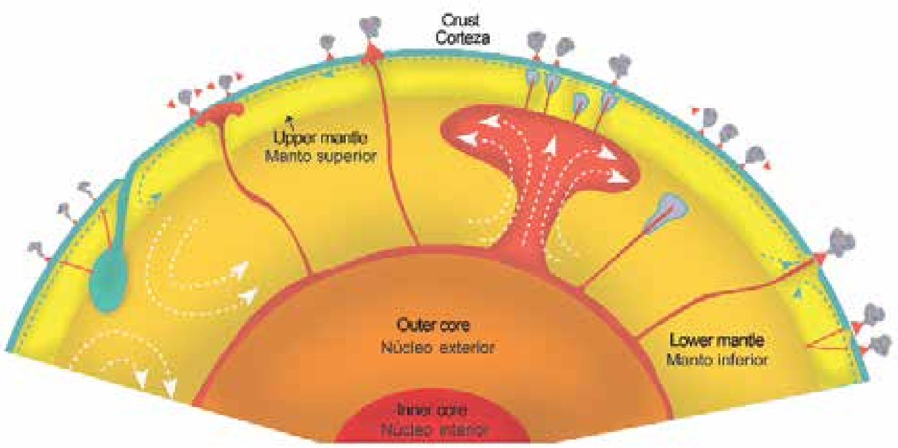

Fig. 1: Summary of different ideas and theories of the origin of hot spots. Adapted and modified from Anderson 2007. CGVG-Theofilos Toulkeridis.

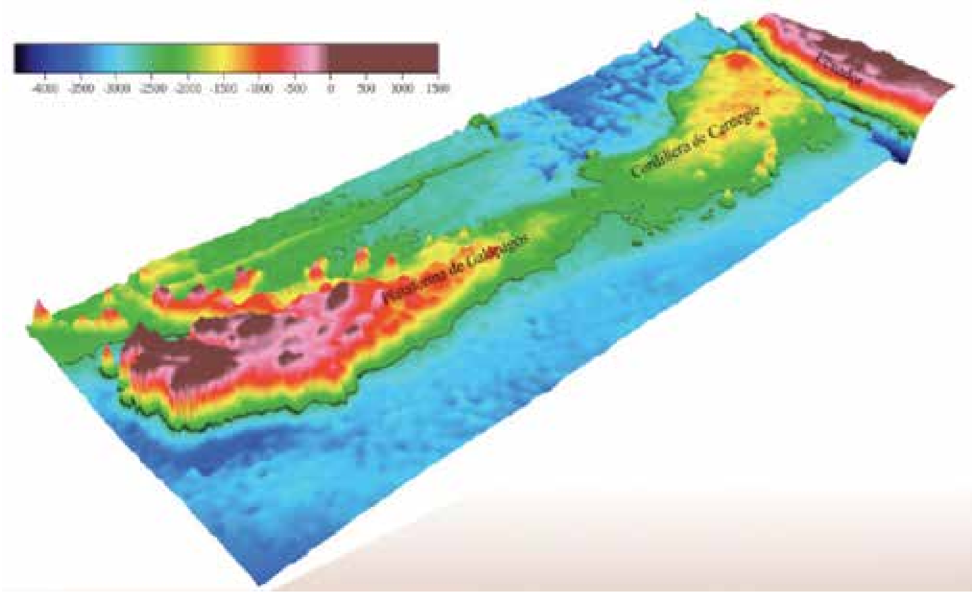

Fig. 2: Three-dimensional panoramic view over the Carnegie Ridge and the subduction zone ahead of the Ecuadorian mainland. Courtesy Giorgio de la Torre

It is assumed that over a span of about 90 million years, the combined processes of magma formation, eruption, and continuous movement of the Nazca and Cocos Plate (before the break-up into Nazca and Cocos named Farallon Plate) over the stationary hot spot have left the trail of volcanoes across the ocean floor that we now call the Galapagos - Carnegie - Cocos Ridge Chains. The islands of Fernandina and Isabela, the westernmost and youngest island, presently overlies the assumed hot spot and still taps the magma source to feed its currently active volcanoes, at Alcedo, Sierra Negra etcetera. The other active volcanoes further to the east such as Marchena may mark the end of the zone of magma formation at the eastern edge of the hot spot. The other Galapagos Islands active such as San Cristobal, Española and a few others have moved eastward beyond the hot spot, were successively cut off from the sustaining magma source, and are theoretically no longer volcanically. The progressive easterly drift of the islands from their point of origin (with the exception of the islands Wolf and Darwin) over the hot spot is well shown by the ages of the principal lava flows on the various Galapagos Islands from east (oldest) to west (youngest), given in millions of years such as San Cristobal 2.5 Ma and Fernandina less than 0.7 Ma and still growing. The size of the Galapagos hot spot is not known precisely, but is presumably large enough to encompass the currently active volcanoes of Fernandina, Isabela and potentially Marchena besides others.

Some scientists have estimated the Galapagos hot spot to be about 150 km across, with much narrower vertical passageways that feed magma to the individual volcanoes. Once again, it's just one of many geological explanation for the Galapagos Islands, which postulates a small area of abnormally hot rock, a "hot spot" deep beneath the ocean floor.

The hot spot is firmly rooted in the Earths interior, while the bedrock of the ocean floor glides slowly over it. Molten rock erupts from the hot spot onto the

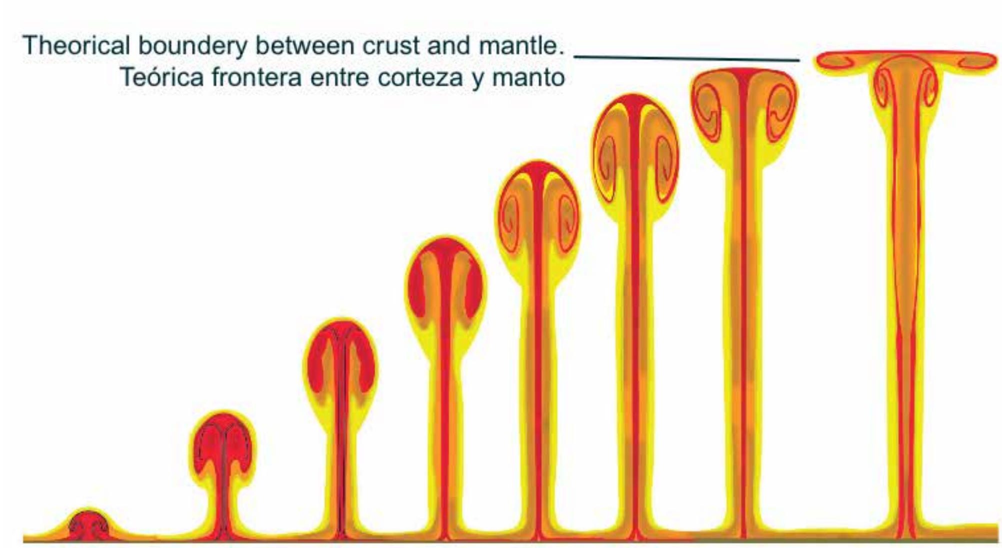

Fig. 3: Experimental phases of the development of the uprise of a mantle plume. Note the flatness of the head of the plume when reaching theoretically the lower part of a plate. CGVG-Theofilos Toulkeridis.

ocean floor and builds a volcano, which grows above the waves until the ocean floor carries it far to the east. Beyond its lava supply, the old volcano goes out of business, and a new volcano begins to build above the hot spot. It might be curious to imagine that solid rock flows in convection currents inside the Earth due to the fact that we know the rocks at the Earths surface are cold, stiff and brittle, but it does so in the Earth's interior where very high pressures and temperatures rule. Under such circumstances, rocks become soft and plastic in much the same way that hard wax becomes soft and pliable as it warms in ones hand. The general assumption is that hot rock in the upper mantle sometimes rises in narrow plumes, like smoke rising from a chimney (Fig. 3). A plume head heats the lower side of the Earth´s outermost solid layers of the lithosphere, and, when the mantle plume has burned its way through, it leads to the expulsion of a massive amount of basaltic flows, which may form large igneous provinces that include huge oceanic plateaus.

Recent evidence supports the interpretation that the thickened (nowadays located NE to the Galapagos) Caribbean Plate represents a large igneous province associated with the initial impact of the Galapagos plume head upon the base of oceanic lithosphere. Hot spots are undetectable by most of the conventional methods used to examine the Earths interior. Geoscientists of all kinds have no firm data to help explain how hot spot plumes start rising, or from what depth. The vapors blowing out of Galapagos volcanoes, especially at the Sierra Negra volcano, contain surprisingly high concentrations of some very rare elements, which are not frequently found in the "regular" Earths surface.

Some geologists regard this as evidence that the plume is rising from an extremely deep root. Others do not. Some geologists believe that hot spot plumes start spontaneously where large masses of hot rock rise from peaks in the boundary at the top of the Earths molten core. Others suggest that they originate at depths of only 650 to 670 km, where we encounter the boundary of Earths upper and lower mantle, where pressures forces the abundant mineral olivine to change its crystalline structure, forming a boundary from which escaping heat can rise.

A further group of geologists believe that a hot spot rises due to subducted oceanic crust may does not melt completely at subduction zones. This so far at a first step non-melted part turn into a loop and sinks either at the Earths upper/lower mantle boundary or even to the lower mantle outer core boundary at 2900 km depth and after a certain residence time becomes in a way "recycled", and because of this "recycling" process, it becomes lighter and therefore less dense, which leads this material to rise up and form a hot spot (Fig. 4).

Some geologists even speculate that plumes develop at sites where enormous asteroids strike the Earth and explode, opening a path for heat to escape from the interior. However, for all theories real data are still lacking.

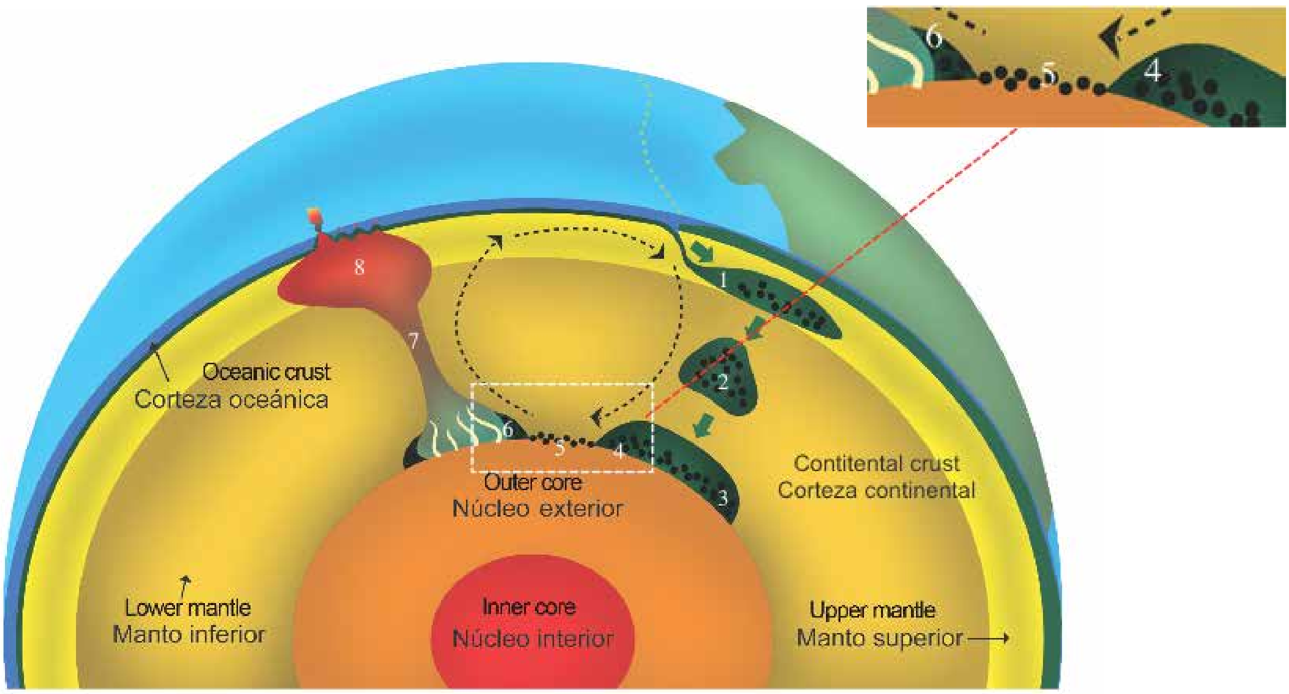

Fig. 4: The so far most accepted theory of the origin of a hot spot deals about the "cemetery of the continents" explained in eight steps. 1 – An oceanic plate gets into subduction. 2 – Not all oceanic plate is used in formation of volcanoes or in re-melting in the upper mantle. The oceanic plate sinks towards the outer core. 3 – Once reached there it remains at this heat boundary for a long time. 4 – A certain separation of heavy elements such as iron starts to happen due to the fact, that the sunken plate got cooked at the core-mantle boundary. 5 – The iron and other heavy elements got separated from the "dead" plate and got accumulated at the core-mantle boundary. 6 – The now lighter or less dense upheated residual material of the previous dead plate starts uprising. 7 – The uprise forms a heat column, fixed to its roots. This hotspot is hotter than the environment it crosses through. 8 – Once reaching the surface while crossing in this case an oceanic plate is supplies new formed volcanoes with upcoming magma. CGVG-Theofilos Toulkeridis.

Nonetheless, a large and growing fraction of scientists conclude based on their data that mantle plumes simply don't exist. Their theory explains the presence of a volcanic Galapagos by simple cracks or fissures in tectonic plates. After all, plates stretching 10,000 kilometers are unlikely to remain perfectly intact. If any break in the skin of a plate exists, it seems reasonable that molten rock would flood up to fill this potential gap. This would explain volcano formation without any mantle plume.

Nonetheless, summarizing we can say at least that "hot spots" can be defined as long-term sources of volcanism which seem relatively fixed compared to the plates. However, whichever theory one follows, uncertainties always remain. By trying to bury one controversy, one may have dug up another. Scientists are willing to admit that the geological community is standing on the brink of a radical shift in thinking that could completely change our ideas about the inner workings of the Earth in the very near future, especially with the generation of data by new techniques such as mantle-tomography combined with conventional (isotope-) geochemistry.

Anderson, D.L., 2007: The New Theory of the Earth. Cambridge University Press, 2nd edition: 400 pp.

Observations on vertebrate remains from Galapagos lava tubes

Rickard S. Toomey, III.

Mammoth Cave International Center for Science and Learning, Mammoth Cave National Park, Kentucky, United States.

Vertebrate remains (mostly bone) are common in many settings in Galapagos lave tubes. They occur where animals fall or are thrown into tubes, where animals are brought into caves by predators (such as owls), and where animals come into the cave and happen to die. Often bones are found on the surface in the tube; sometimes they are on bare lava floors and other times they occur on areas with sediment over the floor. Surface bones that have been dated in previous studies range in age from modern to several thousand years old. In some cases sediment deposits contain bones that are potentially older.

Bone found in the lava tubes include native and introduced species. Native species commonly encountered include giant tortoises, iguanas, various bird species (including owls, petrals, and finches), extinct Galapagos mice and rice rats (genus *Nesoryzomys*), and the extinct giant Galapagos rat (*Megaoryzomys curioi*). Introduced species commonly encountered as bones in the lava tubes include cows, goats, old world rats and mice (*Rattus* and *Mus*), horses, and pigs. The giant Galapagos rat is known only from cave specimens and has never been seen alive.

Owl roosts are a common source of small bones in caves. The owls sample small mammals and birds from around their lava tube roosts. When they return to their roosts, they regurgitate pellets containing bones. This bone accumulates in areas of the lava tube providing a good sample of small animals living around the tubes. Often these deposits have mice and rats (both introduced and native) and small birds such as finches.

Some animals are more commonly found as isolated skeletons (or piles of disarticulated bones)) that represent those animals falling into the cave or going into it to live. Examples of these kind of animals include tortoises, iguanas, giant Galapagos rats, petrals, and various large domestic animals (cows, goats, pigs, and horses).

On Santa Cruz, lava tubes at lower elevation (e.g., Chato, Primecius, Cascajo, Royal Palms, Soyla) tend to have faunas including giant Galapagos rats, tortoises, petrals, and domestic cows, horses, and pigs. Faunas at higher elevation, in the La Llegada trench, have more *Rattus*, *Mus*, finches, and goats; they lack tortoises and giant Galapagos rats.

Cave minerals from a stalagmite in Kimakia Cave (Kenya)

Jim W. Simons[1], Paolo Forti[2], Ermanno Galli[3] and José Maria Calaforra[4]

[1] Cave Exploration Group of East Africa, Nairobi, Kenya [2] University of Bologna, Via Zamboni 67, 40126 Bologna, Italy: paolo.forti@unibo.it [3] University of Modena & Reggio Emilia, Italy [4] University of Almería, 04120 Almería, Spain.

The volcanic caves of Kenya proved to be fairly interesting from the mineralogical point of view even if only a few papers on this topic have been printed until now (Forti et al. 2004).

The Chyulu Hills consist of Holocene to Recent volcanic ash cones and surrounding lava fields (Fig. 1A). They are characterized by large lava tunnel caves (Simons 1998), where often large bat guano deposits were formerly mined from several caves from 1965 to 1992.

Caves were discovered mainly in the vicinities of the Ithundu and Mathaioni Cones, and represent sections of a great tube that originally must have been more than 7 km in length. The Kimakia Cave is one such tunnel section that lies below the Kimabui Hills and near to the Ithundu Cone (Fig. 1C). The cave forms a 1.1 km long tube that is itself broken by a major roof collapse (Fig.1D) with the southern and upstream segment, known as New Maxwell House (Ithundu Mine) being around 0.6 km long and anywhere

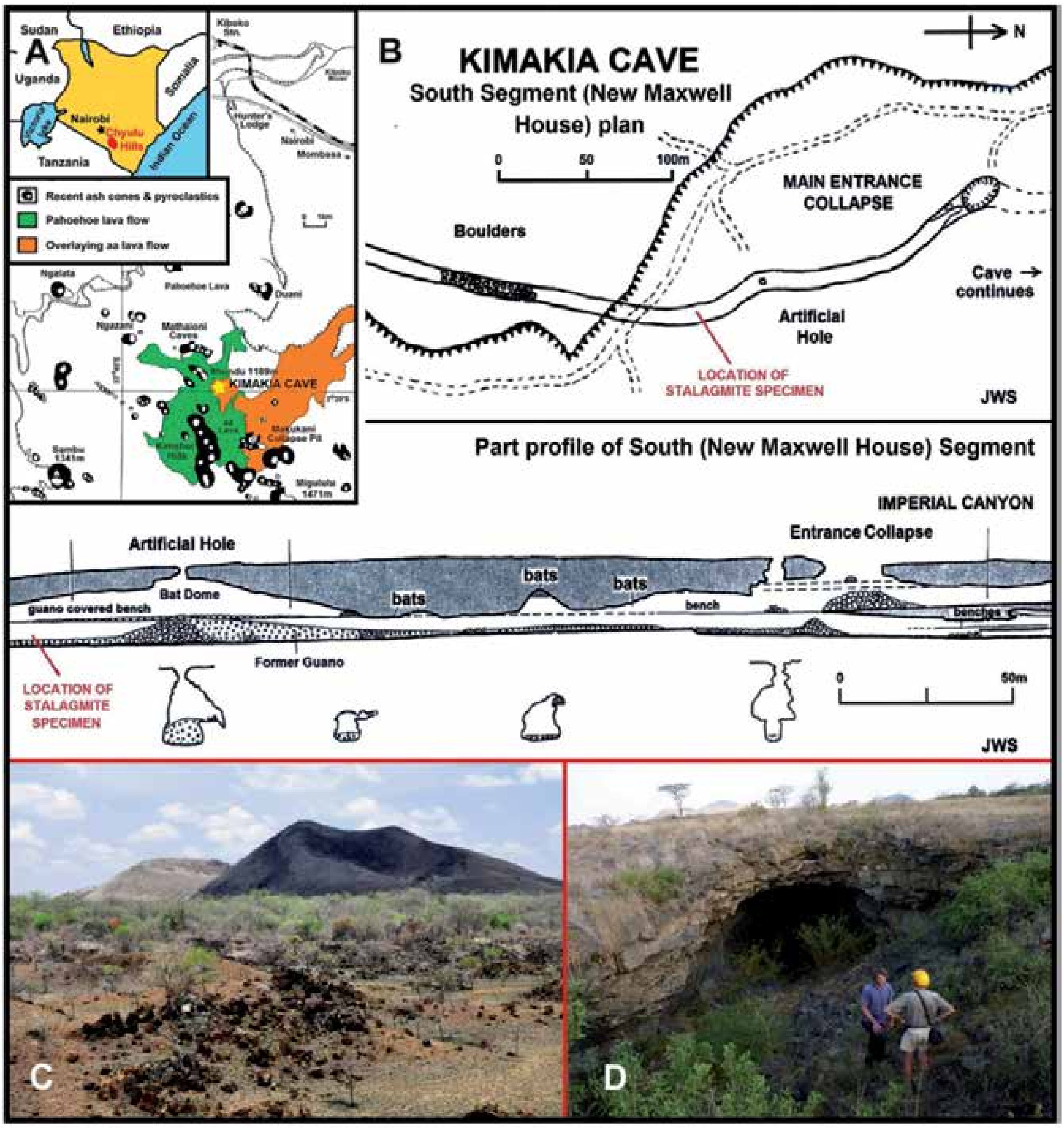

Fig. 1- A) index map and simplified geological map; B) Partial plan and profile of Kimakia Cave showing location of guano-related secondary formations; C: General view of the area of the Kimakia Cave with the Ithundu Cone; D: Main collapse entrance into the cave, facing upstream into the New Maxwell House (South) segment (Photo. B. Goderis)

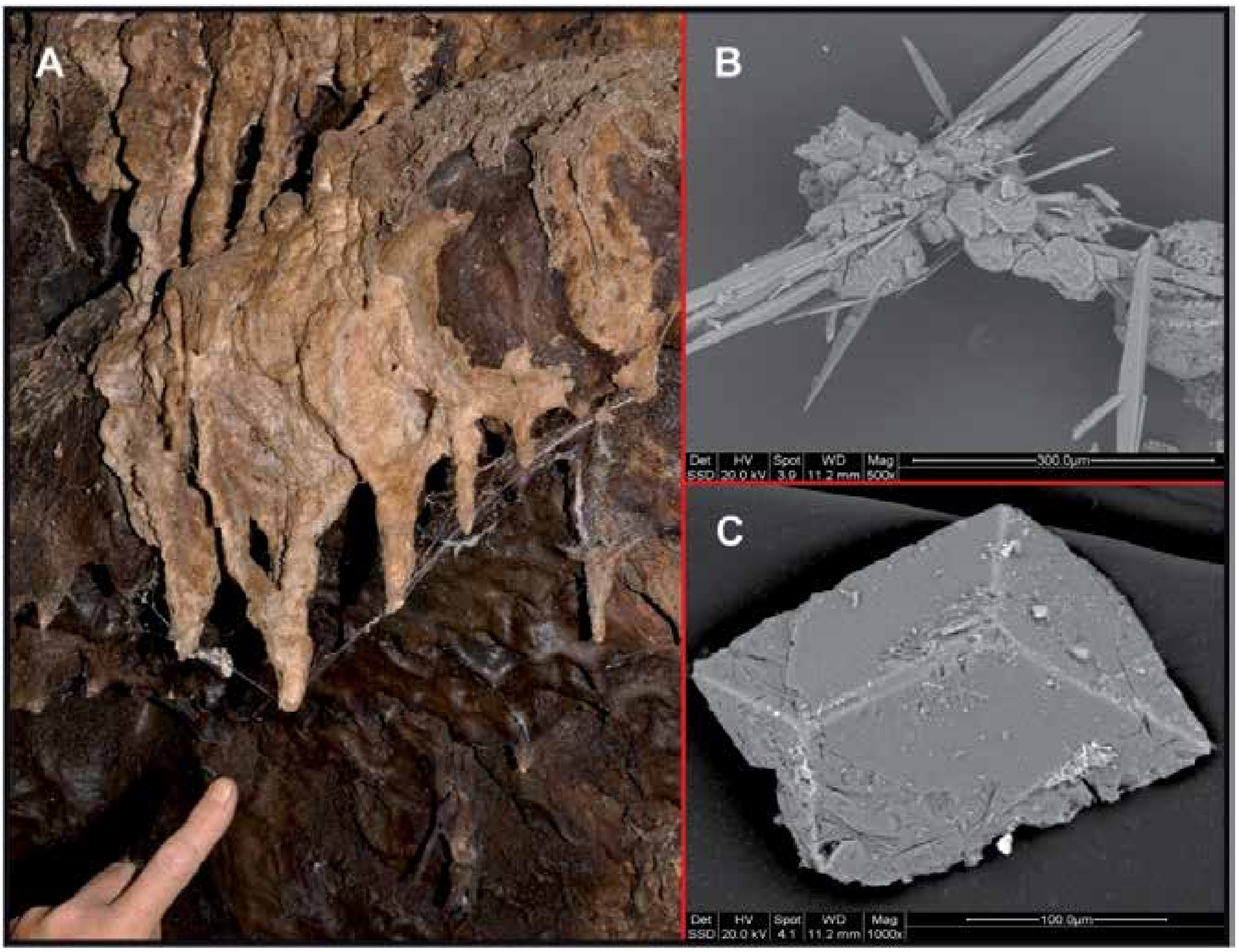

Fig. 2- A) secondary stalactites hanging below a guano covered bench (Photo. C. Ward); B) SEM images of tabular crystals of intimately mingled struvite and dittmarite over acicular apatite crystals; C) SEM image of an euhedral crystal of dittmarite (prevailing) and struvite.

between 10 m to 12 m in diameter (Fig. 1B). Former guano deposits not only covered the cave floor in this section but also many of the benches along the walls. Secondary speleothems particularly occur beneath the former guano covered benches, especially between 10-20 m beyond an artificial hole created in a high dome to facilitate the removal of the guano.

These formations take the form of conventional stalactites (Fig.2A) or (formerly) delicate straws up to 30 cm long, both hanging from below upper and lower benches. These sometimes have erratic growth connections probably influenced by spider webs. Occasional stalagmites, up to 30-40 cm high, once occupied a hollow between benches and a rare column with flowstone still remains intact. In the past

it was proved that some of the stalactites consist of opal ($SiO_2.nH_2O$) (Simons 1974). A sample from an already toppled stalagmite, was recently recovered to be analyzed.

2- Mineralogical composition of the stalagmite

The analyzed sample had an external color from pale pink to pale grey and its internal structure was partially layered consisting of earthy milky white to pale beige-grey crumby spongy and greasy, somewhere silk shining, material. The whole stalactite is characterized by the presence of abundant organic remains (hairs, bone fragments and vegetable fibers).

Small white soft euhedral prismatic crystals (Fig. 2C) and aggregates of tabular silky shining crystals (Fig. 2B) are visible inside most of the small voids within the stalagmite.

Samples have been analyzed by SEM, ESEM, Rx powder diffraction and Gandolfi Camera. The inorganic part of the stalagmite resulted composed by dominant dittmarite ($[NH_4Mg(PO_4)].H_2O$),Struvite ($[NH_4Mg(PO_4)].6H_2O$) and rare apatite, the first two being new cave minerals for Kenya. All these three minerals fully developed thanks to reactions within guano: the scarcity of apatite (perhaps the most common cave phosphate in limestone caves) is here a direct consequence of the composition of the hosting (volcanic) rock. Dittmarite and struvite are often intimately mingled together and it is evident that struvite is the dehydration product of struvite. In fact, in different locations inside the stalagmite, it is possible to observe glassy transparent rhombohedral crystals of pure struvite, or crystal with the same habit but with lots of white grains (struvite and dittmarite) and finally completely silky milky-white crystals of pure dittmarite.

At the moment it is not clear if the dehydration processes leading to the development of dittmarite from struvite are reversible, being controlled by the alternation of wet and dry season in the Kimakia cave area, or irreversible. In this last case struvite will ultimately transform entirely into dittmarite.

3- Final Remarks

The mineralogical study of a broken stalagmite from Kimakia Cave allowed to discover two new cave minerals for Kenya, the genesis of which is strictly linked to the (former) presence of huge guano deposits inside the cave. Even if only very scarce mineralogical investigations have been done in the volcanic caves of Kenya (Forti et al. 2003), the total number of presently known cave minerals is 24 and it is highly probable that many others are waiting to be discovered in the near future.

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Zircon Inheritance in the Lesser Antilles intra-oceanic arc (Grenada and Carriacou Islands): No basement origin but recycling of sediments in a juvenile intraoceanic arc

Yamirka Rojas-Agramonte
ESPE-Universidad de las Fuerzas Armadas

The Lesser Antilles volcanic island arc extends for more than 800 km from north to south and constitutes the best example in the world where to study the phenomena associated with the subduction of oceanic crust and sediments. This intra-oceanic arc is famous for having the most "continental crust-like" geochemical characteristics of all island arcs (Chauvel et al., 2012). Numerous studies have highlighted the strong geochemical and isotopic changes of lava composition from north to south along the Lesser Antilles arc, which is probably the result from the changing age and composition of the subducting material in front of the arc system. The southern islands in the Lesser Antilles (e.g. Grenada, Saint Vincent, Saint Lucia) provide an opportunity to investigate the effects of sediment involvement in the generation of arc crust by means of intra-oceanic subduction. The sediment-derived fluid contribution to the mantle source in the southern Caribbean islands is related to the presence of a large (Barbados) accretionary complex of more than 10 km thick of sediments with a large proportion of terrigenous turbidites and U-rich black shales. However, the extent of the sediment input to the mantle wedge is still debated and controversial. The Orinoco and Amazon Rivers, which drains the South American continent (e.g. Guyana Precambrian shield and Brazilian craton), are the main source of terrigenous sediments that "contaminates" the trench of the southern Lesser Antillean arc.

Our study in the islands of Grenada and Carriacou (as part of the Grenadines chain) shows for the first time the existence of Paleozoic and Precambrian xenocrysts within Pleistocene lavas and mostly Cambrian and Precambrian zircons recovered from beach and river sands. Such findings are providing us some initial answers concerning the source of sediment contamination and how zircons may survive subduction and become introduced into the mantle wedge before becoming incorporated into peridotite-derived basaltic magma.

The REE pattern of Grenadan samples is generally similar, showing LREE enrichment and fractionation and depletion of HREE and no Eu anomaly. The absence of a negative Eu anomaly indicates that plagioclase plays a relative minor role in the fractionation process in spite of its abundance as phenocryst in many of the lavas which probably indicates that plagioclase has accumulated in the lavas because of its low density contrast with the melt. The zircon REE patterns is similar with a weak negative Eu anomaly in agreement with the whole rock REE analyses, suggesting that zircons crystallized from a melt after little plagioclase fractionation.

The trace element chemistry in all analysed zircons suggests crystallization from a "continental" crust, suggesting that the grains crystalized from a melt contaminated with sediments with a large component of old continental material.

Except for one sample with a low εNd(t) value (0.2), all dated samples show a remarkably positive εNd(t) values (3.3 to 5.9) suggesting a juvenile source for these rocks which is difficult to explain in such rocks showing sedimentary contamination. One explanation could be that the Sm-nd system generally reflects the end-product of magma formation and mixing and therefore may mask details of important petrogenetic processes taking place in such melts. The εHf in zircons are also positive (except for one sample with negative εHf values) but quite heterogeneous, suggesting crustal contamination and that the source of these zircons is also heterogeneous. The major heterogeneity is probably due to some magma mixing.

Þríhnúkagígur

Árni B. Stefánsson

The progress of the Þríhnúkagígur project has been slower than expected but steady, since the report on the 13th International Symposium on Vulcanospelelogy on Jeju Island in S. Korea in 2008.

In November 2009 the report; *The Access of Þríhnúkagígur, preliminary investigation*, was delivered. The report proved/showed the crater can be accessed in the proposed way. That is, with a 300 m long tunnel from the SE, viewing balcony 64 m below the entrance and 56 m above the bottom and a spiral staircase down from the balcony.

Þríhnúkar ehf was expanded in June 2010. The city of Reykjavík, the municipality of Kópavogur, Icelandair and a pension fund came in as additional shareholders. The new shares 40 mi. Icelandic krónas, equiv. of 350.000 USD, were spent on an expensive environmental assessment / agreements, which was delivered in June 2012. Planning, consultations, agreements and liences were ok. Continuation is however postponed until the organisation of the far waterreserve area of the capital and the neighbour municipalities has been revised. This revision is considered a formality, but the project has to wait until an agreement has been reached. (An agreement is expected towards the middle of 2014.)

The National Geographic did a documentary on volcanos in Iceland, including Þríhnúkagígur in 2010. A special lift system was constructed for the filming. When the chamber was flood lighted the true colors came to view for the first time. Since 2010 BBC and several other national and other televison companies have made documentaries. Between 70 and 80 major articles have appeared in newspapers and travel news worldwide.

Because the lift system showed itself to be reliable, a nonprofit tourist firm, 3 H Travel, was established for several purposes. 1. To get a feeling for the effect the crater has on visitors 2. Finance research. 3. Research. 4. Finance land management. 5. Land management. 6. Maintain rights. 7. Get a better feeling for the the crater and to get to know it better.

Several members of the Commisson on Volcanic Caves have visited Þríhnúkagígur. Jan Paul van der Pas in September 2010, Martin and Kirsty Mills in June 2012, Diana Northup and Kenneth Ingham in June 2013 and Greg Middleton in August 2013.

A few slides, NTV inteview with Diana Northup, 3D video of the crater, a NTV video of a 1:100 plywood model of Þríhnúkagígur and pictures of a 1:100 wrought iron model will be shown.

Subaquatic opaline stromatolites in Branca Opala lava tube (Terceira, Azores Islands).

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Silica stromatolites occur in a number of modern hydrothermal environments, but their formation in caves is very rare. The opaline stromatolitic speleothems of the Branca Opala cave (Terceira Island, Azores), however, provide an excellent opportunity for their study. These opaline stromatolites may be analogous to ancient silica stromatolites seen around the world.

The Branca Opala cave is located in the northwest of Terceira Island (Basaltic Fissural Zone) (Fig. 1) in a basaltic flow of the eruptive episode of the Cavernícola Malha - Balcões - Chamusca System (<7130 y) (Nunes, p.c).

The opaline stromatolites grew directly on the volcanic rock or other cave deposits such as silicified plants remains, collapse breccias and volcaniclastic sediments. They are beige and brown in color, and their exterior morphology ranges from cloud-like mounds to bulbous, botryoidal masses of linked domes (Figs. 2A, B and C). The stromatolites range from 1-12 cm in height, have a diameter of 3-15 cm, and their interior shows accretionary laminated and layered structures (Fig. 2D). Their size decreases from the cave center towards the two entrances. The stromatolites with botryoidal morphologies are found mainly on the walls and those with cloud-like morphologies are seen mainly on the ceiling. The stromatolites are always beneath a fossil water level (Figs. 2E), that can be followed throughout the cave. They are not currently growing. Silicified plant remains are found between the stromatolites (Fig. 2F).

The composition and textures of the stromatolites was determined by X-ray diffraction (XRD), standard optical microscopy and scanning electron microscope (SEM) equipped with X-ray energy dispersive system (EDX). Geochemical analyses of whole-rock for major, minor and rare earth elements (REE) were performed using inductively coupled

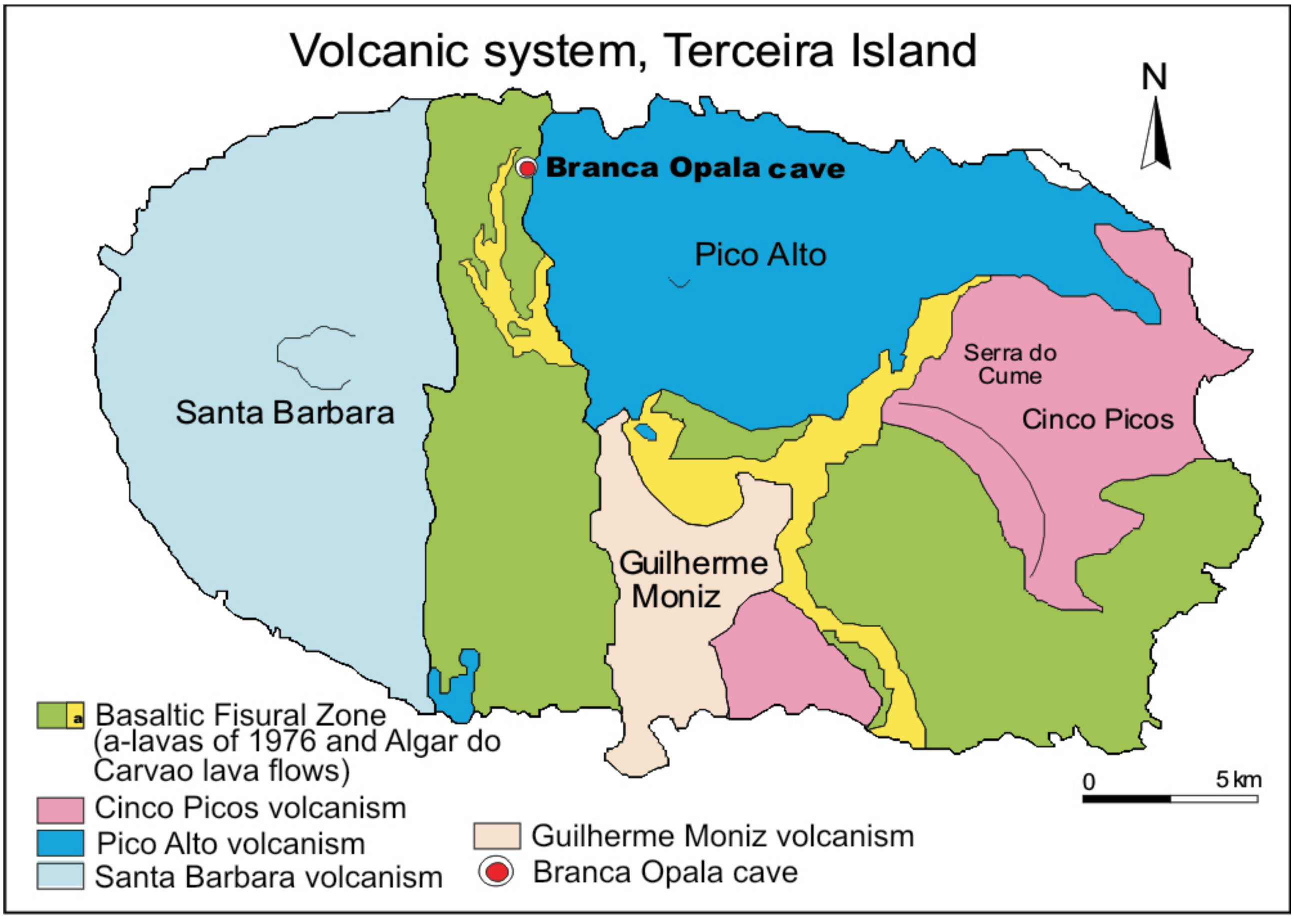


Fig. 1. Location of "Branca Opala" lava tube on Terceira Island (Azores). Geological map modified from Nunes (2004).

emission spectrometry (ICP-ES) and inductively coupled plasma mass spectrometry (ICP-MS). X-ray diffraction analyses showed opal-A to be the sole silica phase. Negligible ordering of this opal-A showed aging to be insignificant, as expected for recent silica deposits. Optical microscopy clearly revealed three parts: a lower microlaminated, an intermediate and a superior microlaminated zone within the stromatolites (Fig. 2C). Stromatolite types (I, II and III) were classified with respect to their internal structure and distribution throughout the cave. The type I (2-15cm), is found throughout the cave, type II (1- 5cm) occurs only at the northern entrance and the type III is stromatolitic crust (1-2cm) and is present on the floor of the southern entrance. Scanning electron microscopy showed silicified bacterial filaments (Fig. 3A and 3B) throughout the three zones described in the stromatolites. Bacteria therefore played a major role in the precipitation of the opal-A.

Plasma emission/mass spectrometry showed major, minor and rare earth elements to be present in only small quantities. These were mainly hosted within volcanic grains.

Rapid silica precipitation from highly super-saturated water would explain the intense silicification of the plant remains found inside of the cave. The opaline stromatolites and the mentioned intense general silicification, suggest a local hydrothermal source for

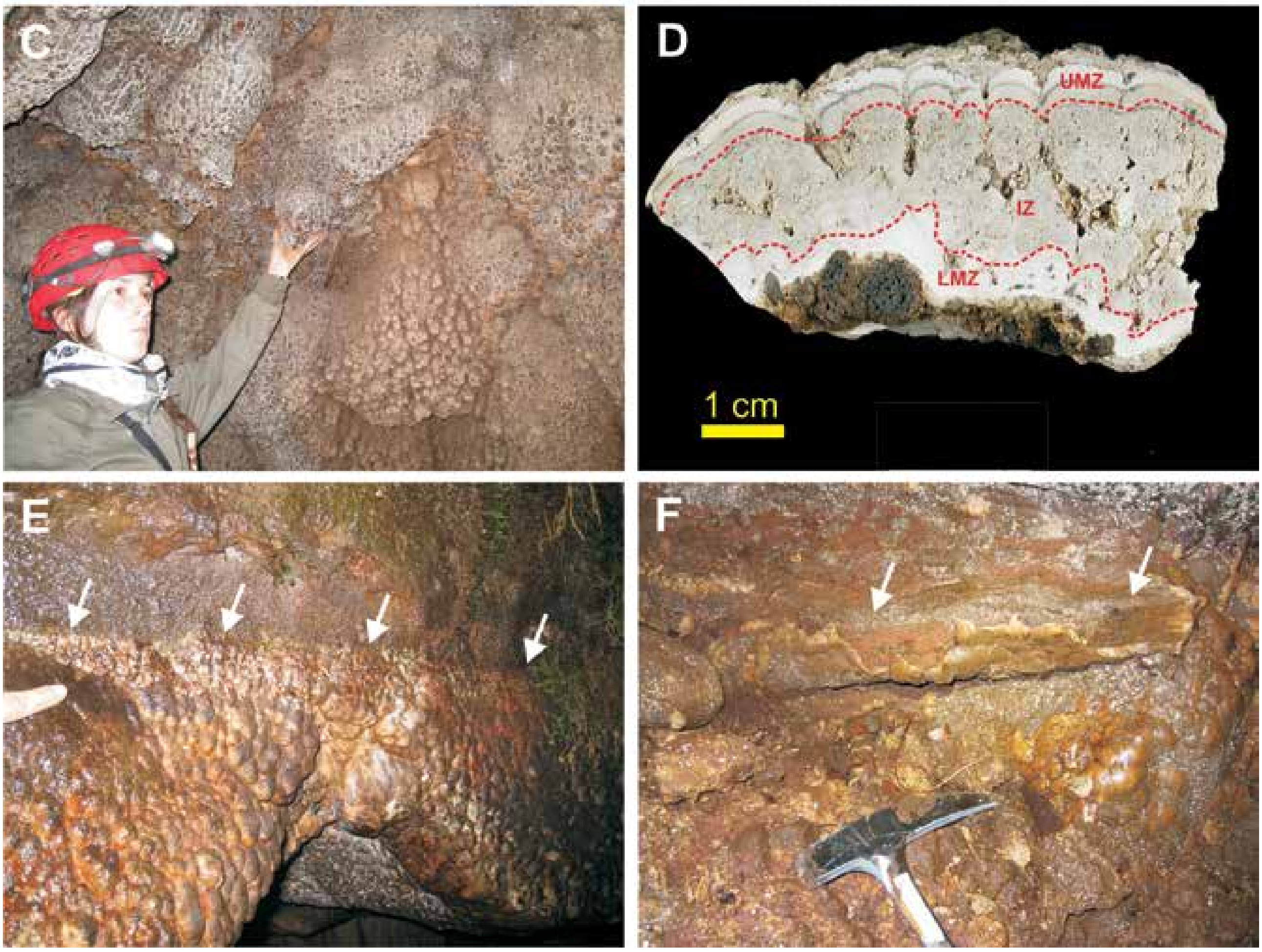


Fig. 2. Opaline stromatolites in Branca Opala lava tube. (A) The north entrance of the cave show cloud-like stromatolites in the ceiling. (B)Botryoidal and cloud-like morphologies in the ceiling of the cave. (C) Botryoidal opaline stromatolites in the walls. (D) Opaline stromatolite section shows three zones: lower (LMZ) and upper (UMZ) microlaminated zones and an intermediate zone (IZ). (E) Opaline stromatolites beneath the fossil water level mark. (F)Detail view of a silicified trunk between the opaline stromatolites.

the silica. Indeed, these deposits strongly resemble plant-rich silica sinter associated with low temperature hot spring deposits that include bacterial filaments. However, no geochemical signals that might indicate a hydrothermal origin could be found.

Acknowledgements: Financial support was provided by project CGL2011-27826-CO2-02 from the Spanish Ministry of Economy and Competitiveness. RD was supported by a CSIC JAE-predoctoral grant co-financed by the European Social Fund.

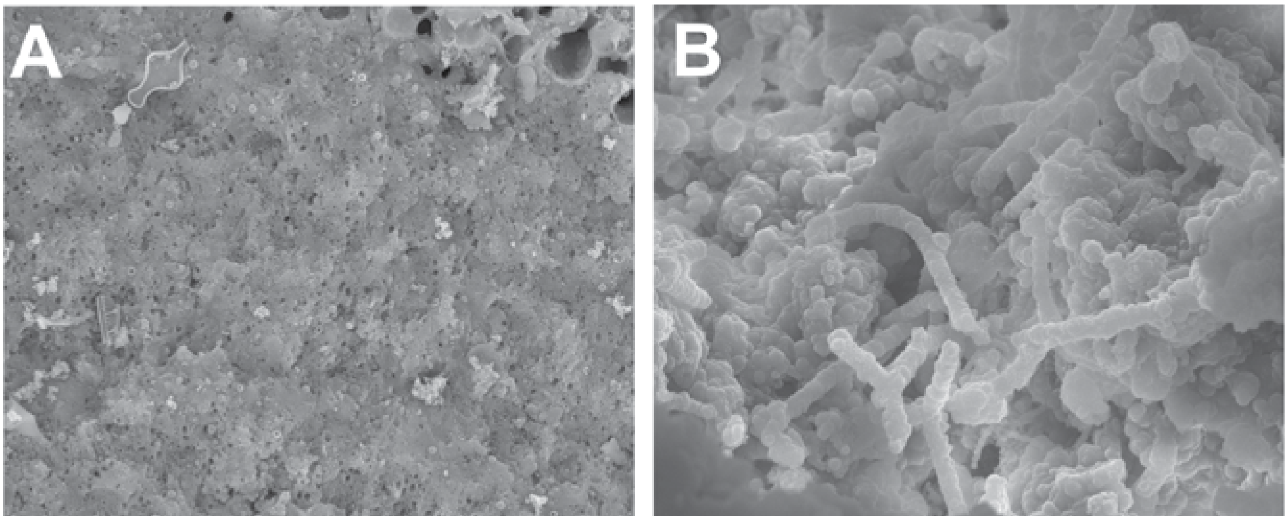
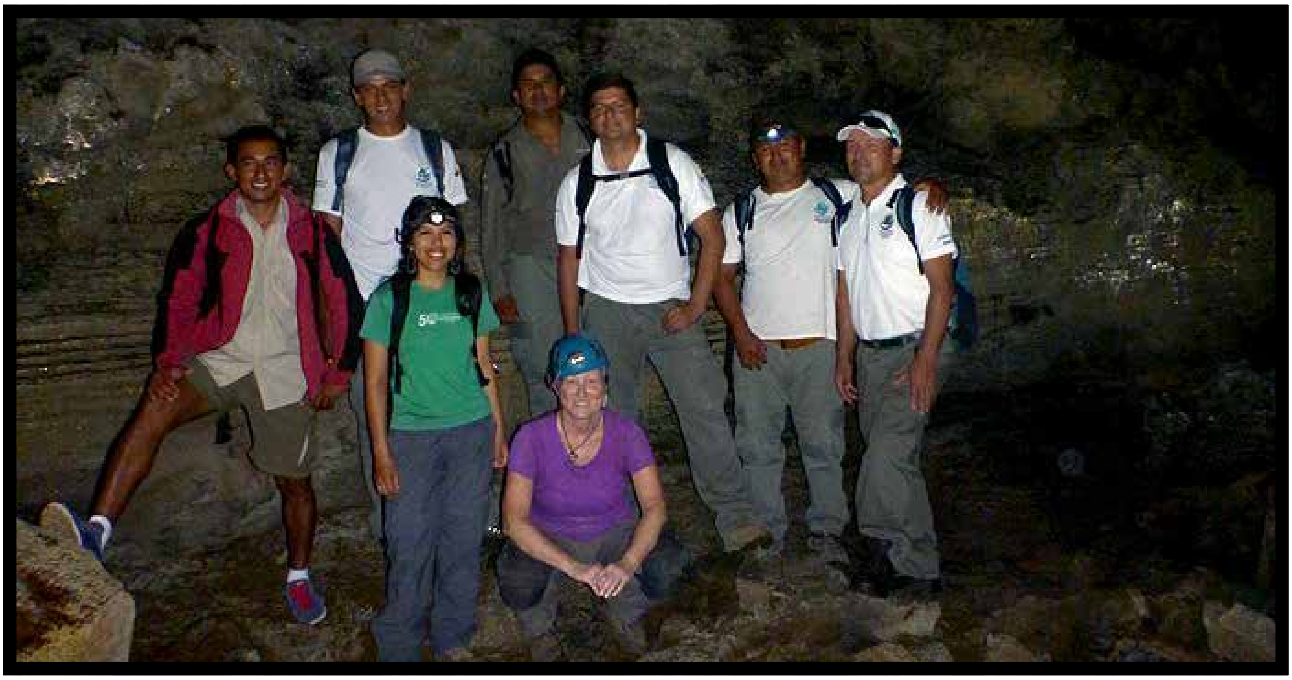


Fig. 3. SEM photomicrographs of bacterial filaments in opaline stromatolites of the Branca Opala cave. (A) Molds and marks of the filamentous bacteria in the microlamined parts. (B)Filamentous bacteria cemented and replaced by opal-A in the intermediate part.

Tuesday 18th of March

7.00 a.m. Breakfast at Hotel Flamingo

8.30 a.m. Bus transport from hotels towards Bellavista. Lunchbox distribution in the bus (entrance).



Galápagos Park rangers with Elizabeth Winkler *Elizabeth Winkler*

Phil Collett

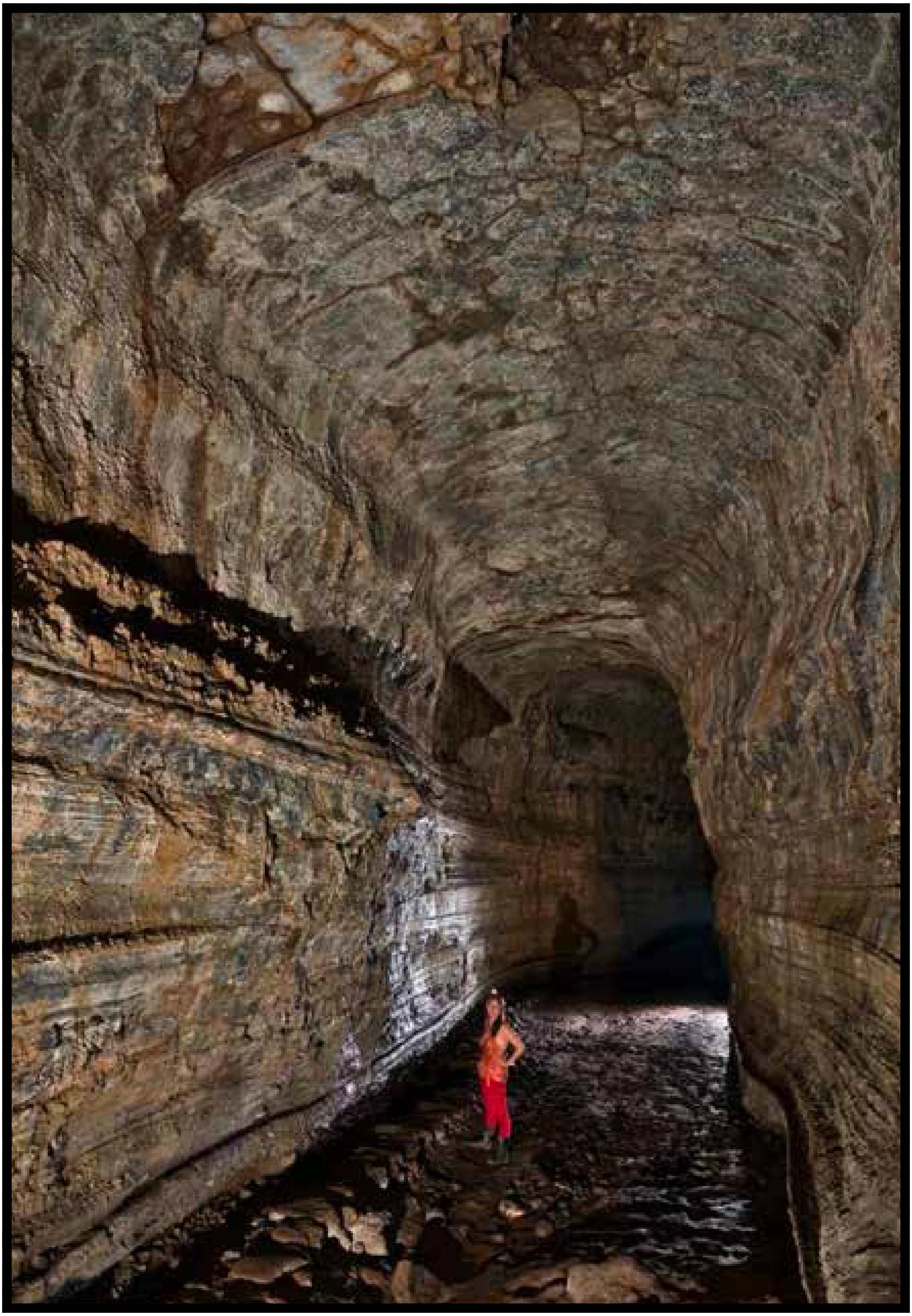
Visit of four caves (Joann, Gilda, Soyla, Gallardo with 80m, 400m, 1000m, 2200m lengths), therefore the groups will be divided into three, rotation during day, guided by Aaron and Galápagos team-members.

17.30 BBQ at Gallardo´s cave.

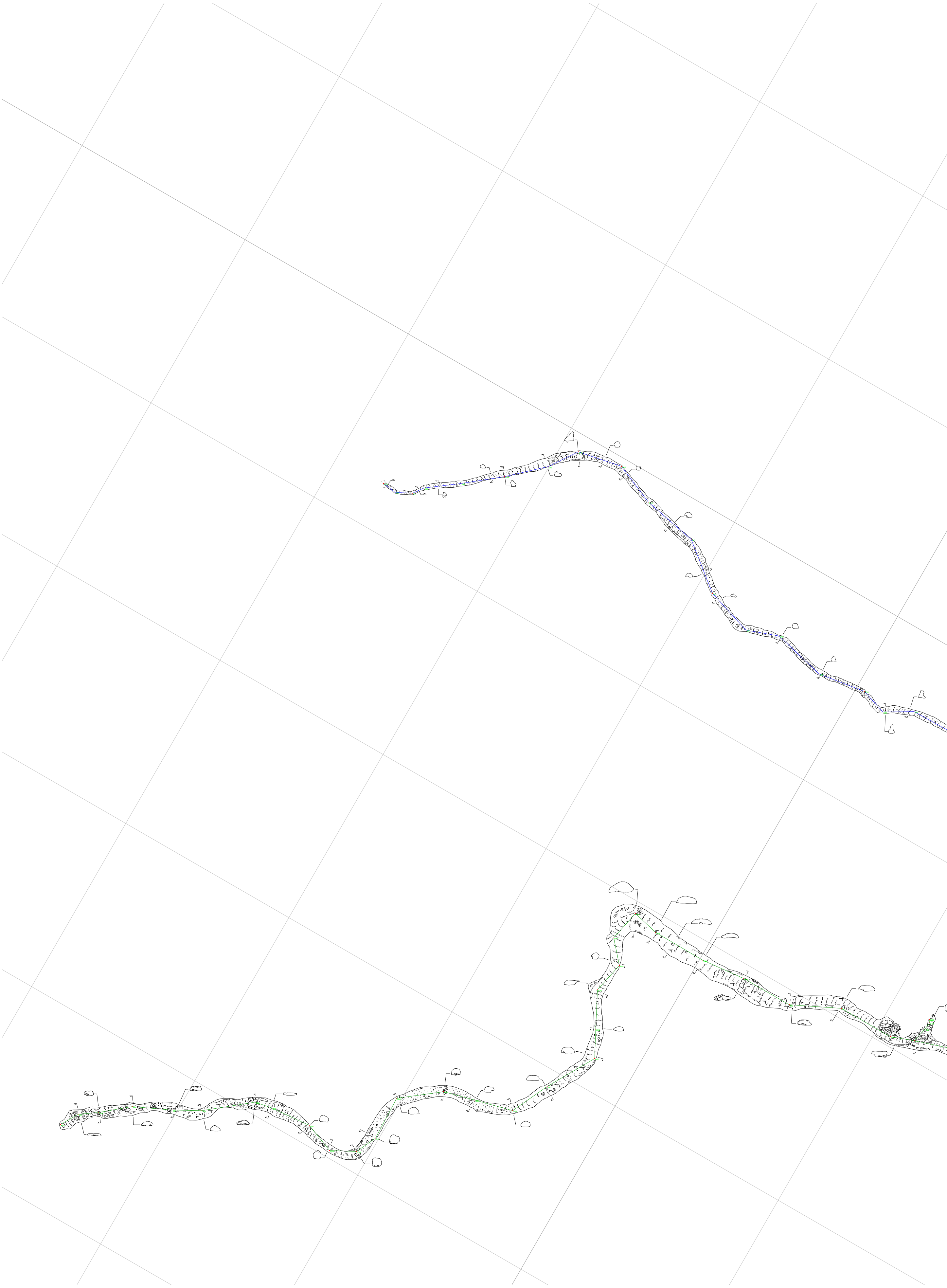
20.00 Transport to hotels

Raquel Daza Brunet

GALLARDO CAVE

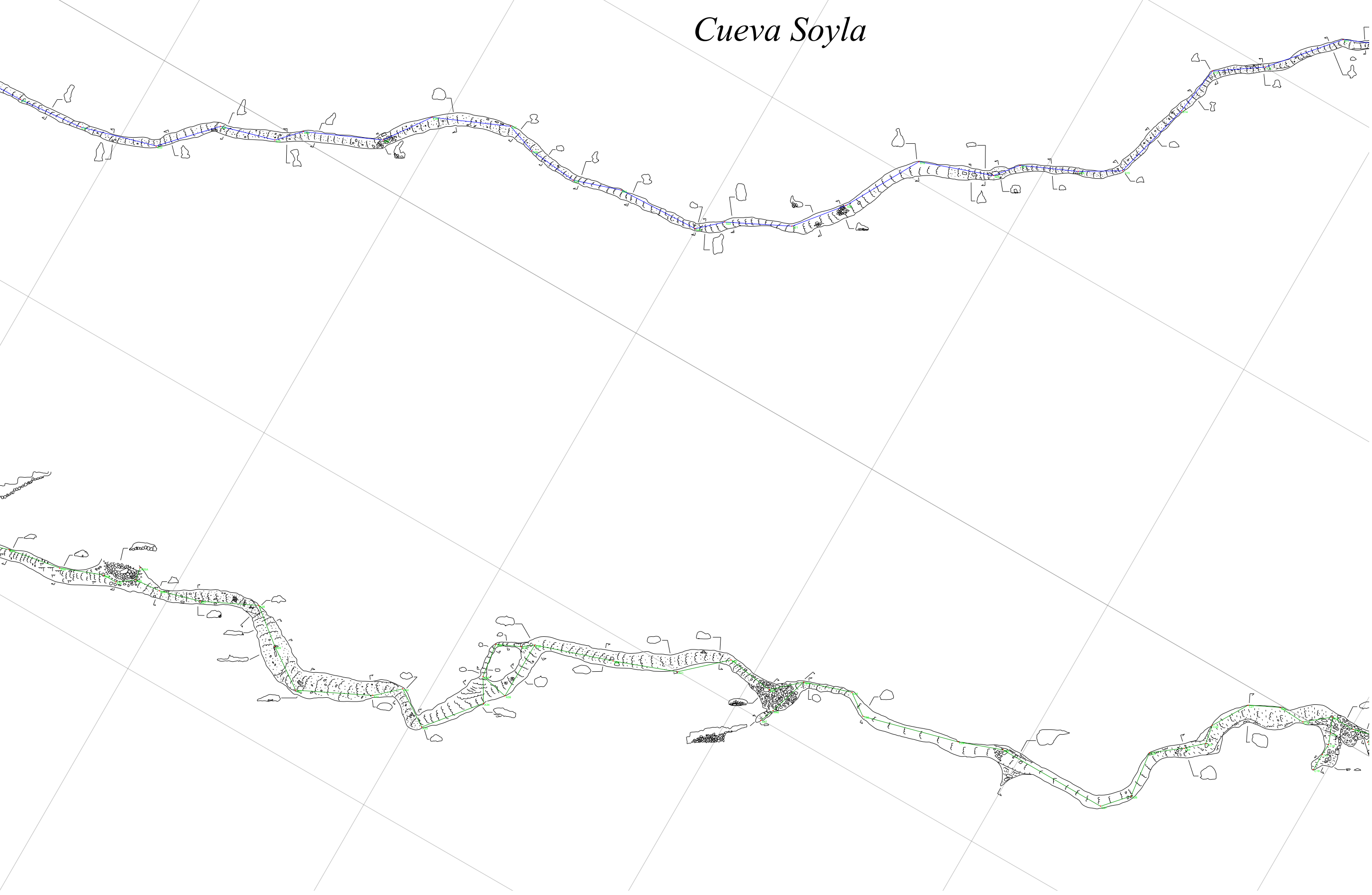


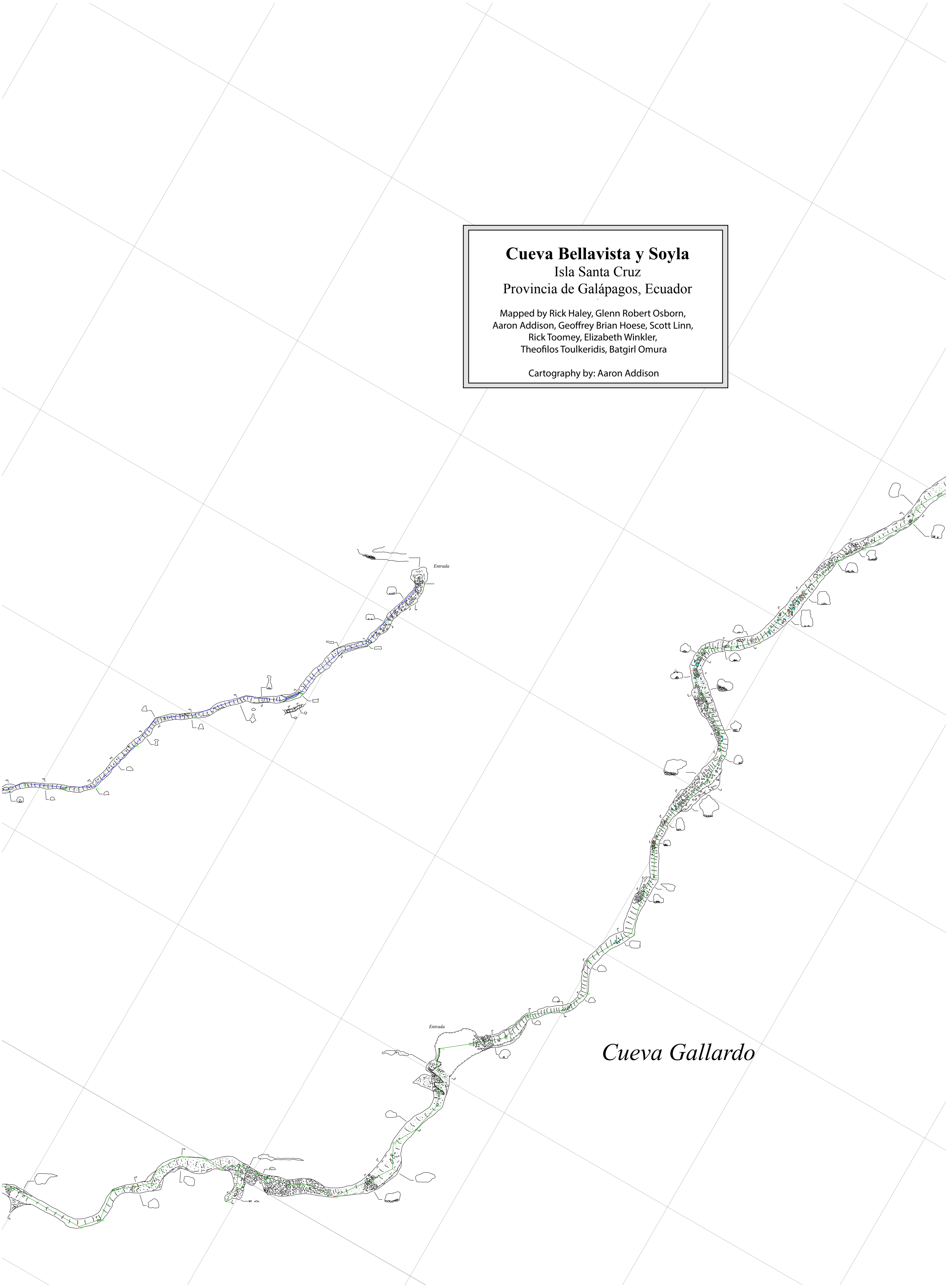
Livia Gallardo, *Dave Bunnell*

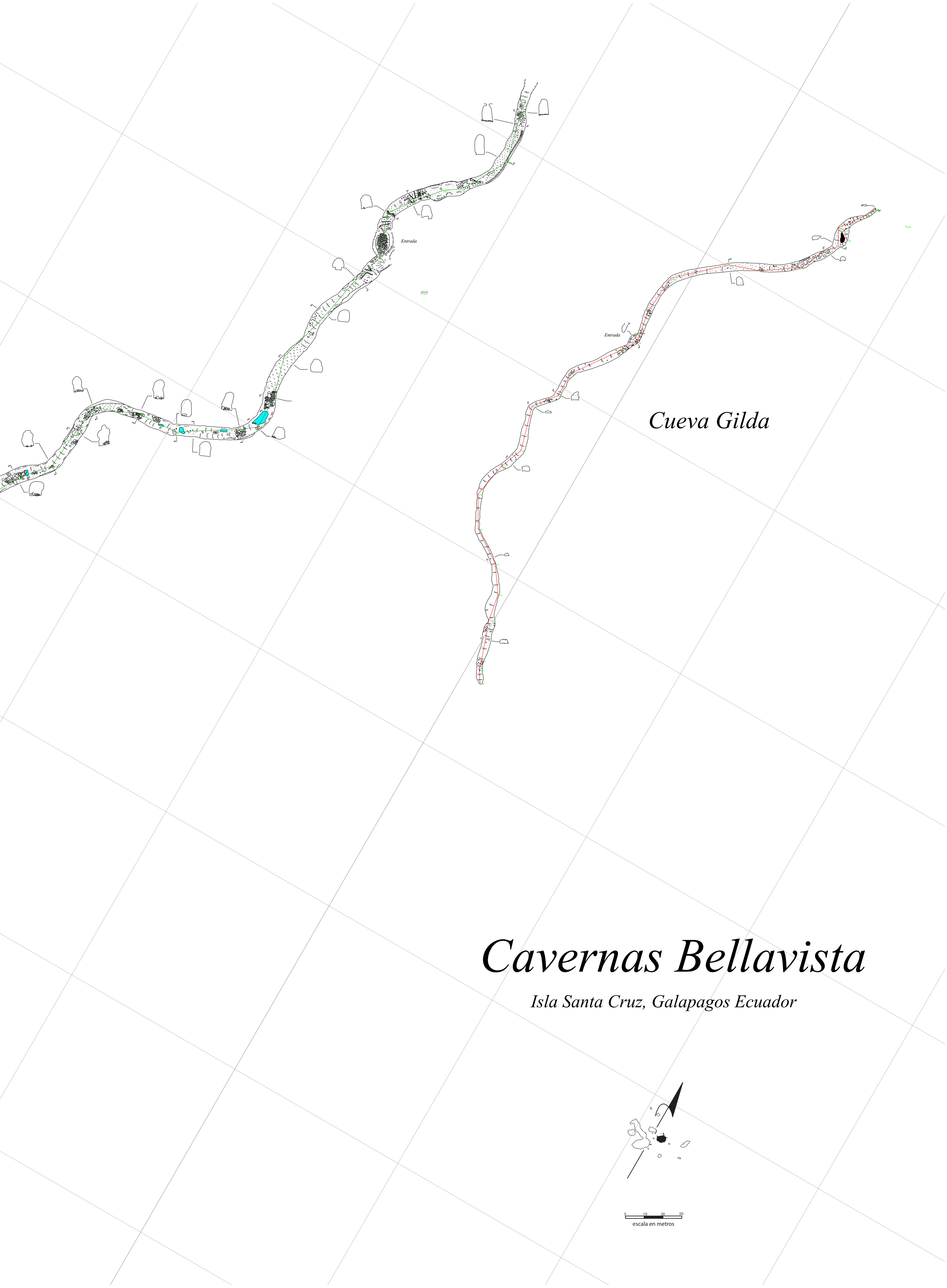


Cavernas Bellavista

Isla Santa Cruz, Galapagos Ecuador




Cueva Bellavista y Soyla
Isla Santa Cruz
Provincia de Galápagos, Ecuador
Mapped by Rick Haley, Glenn Robert Osborn, Aaron Addison, Geoffrey Brian Hoese, Scott Linn, Rick Toomey, Elizabeth Winkler, Theofilos Toulkeridis, Batgirl Omura
Cartography by: Aaron Addison
Entrada
Entrada
Cueva Gallardo



Cavernas Bellavista

Isla Santa Cruz, Galapagos Ecuador

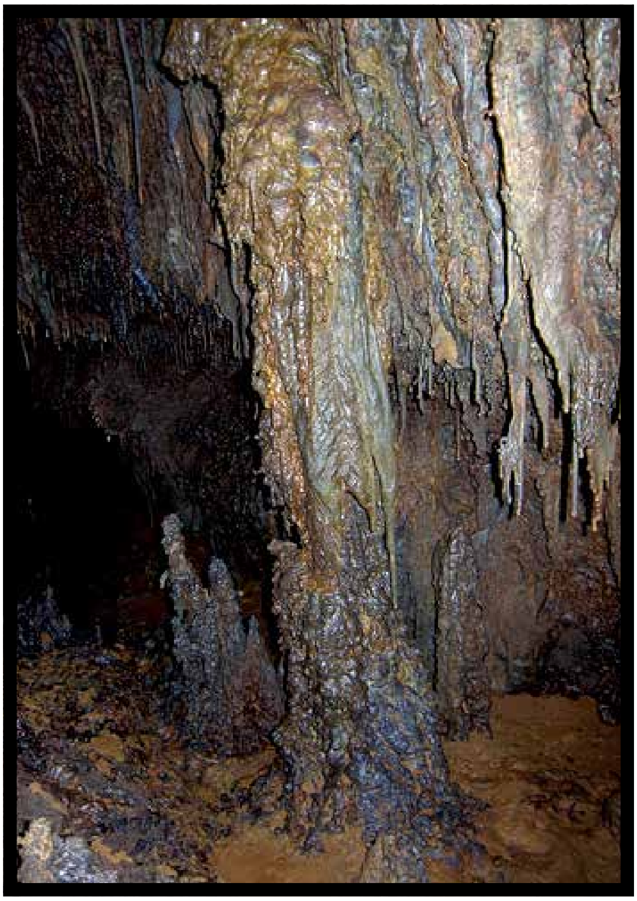
An Bosted

Peter and Ann Bosted.

Bob Osburn Geoff Hoese

Phil Collett

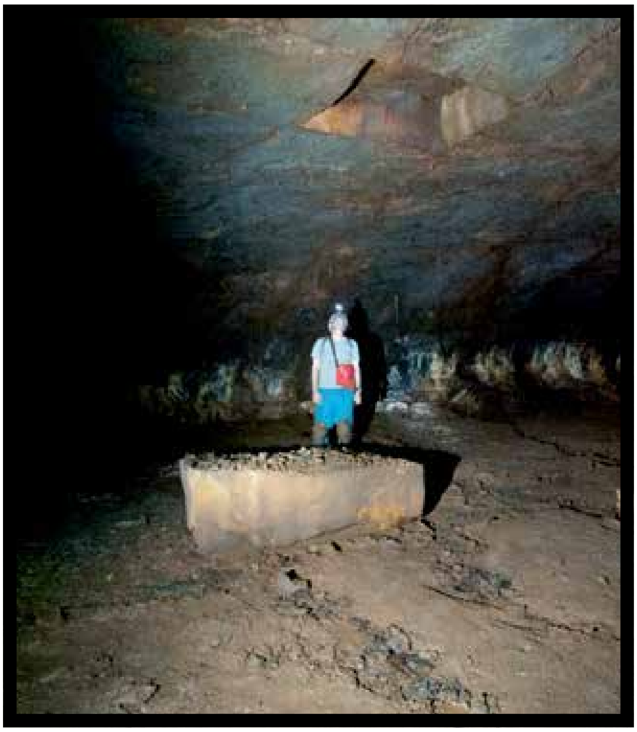
Phil Collett



Phil Collett

Phil Collett

Phil Collett



Scott Linn *Geoff Hoese*

Bob Osburn *Geoff Hoese*

Geoff Hoese

Bob Osburn *Geoff Hoese*

Brigada Villacis *Theofilos Toulkeridis*

Theofilos Toulkeridis


James Carl Patera

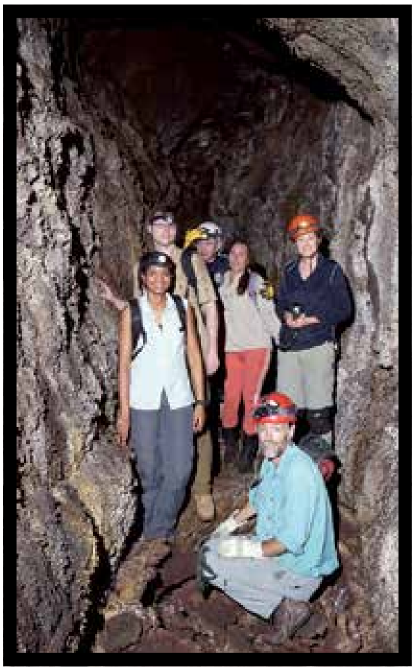

Dave Bunnel

James Carl Patera

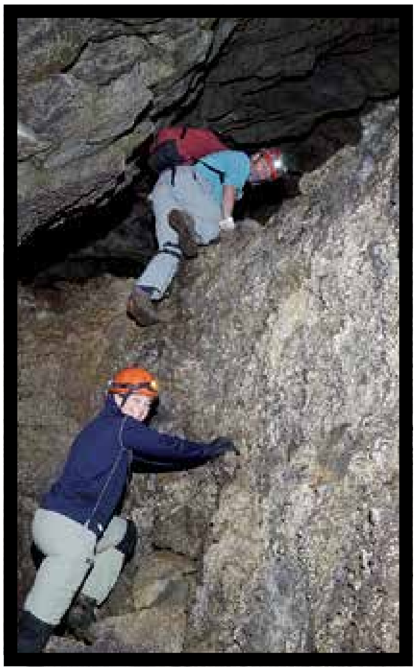
Dave Bunnel

JOANN CAVE

Greg Middleton



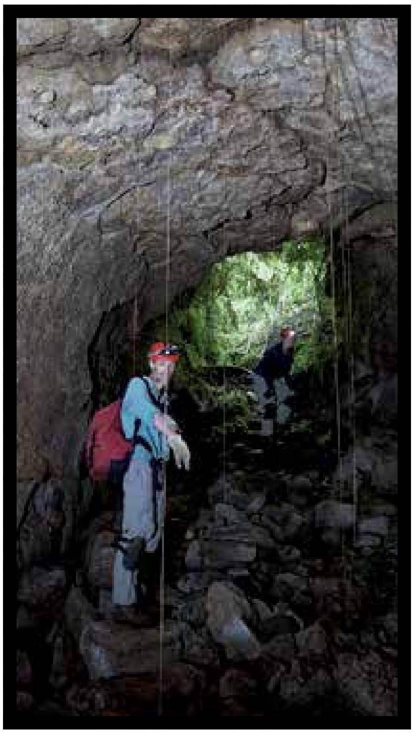
Rojas, Suhr, Toulkeridis, Gallardo, Plowman, Butler *Greg Middleton*



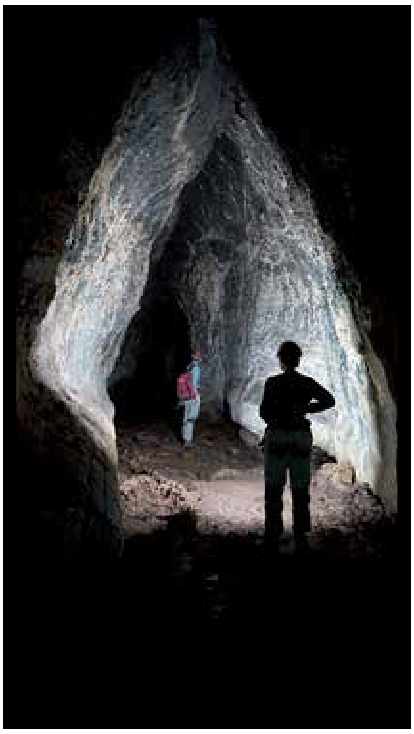
Butler, Plowman *Greg Middleton*

Plowman in the backyard and Butler in the foreground *Greg Middleton*

GILDA CAVE



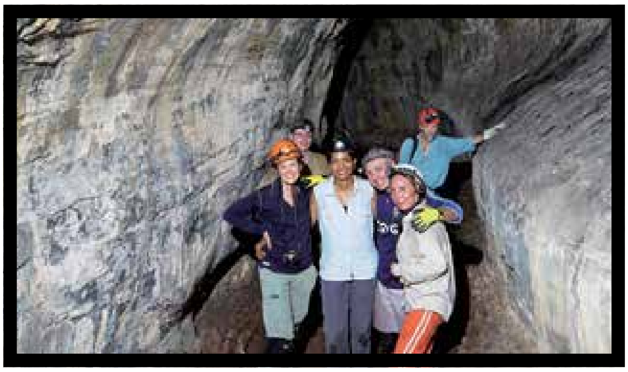
David Butler *Greg Middleton*



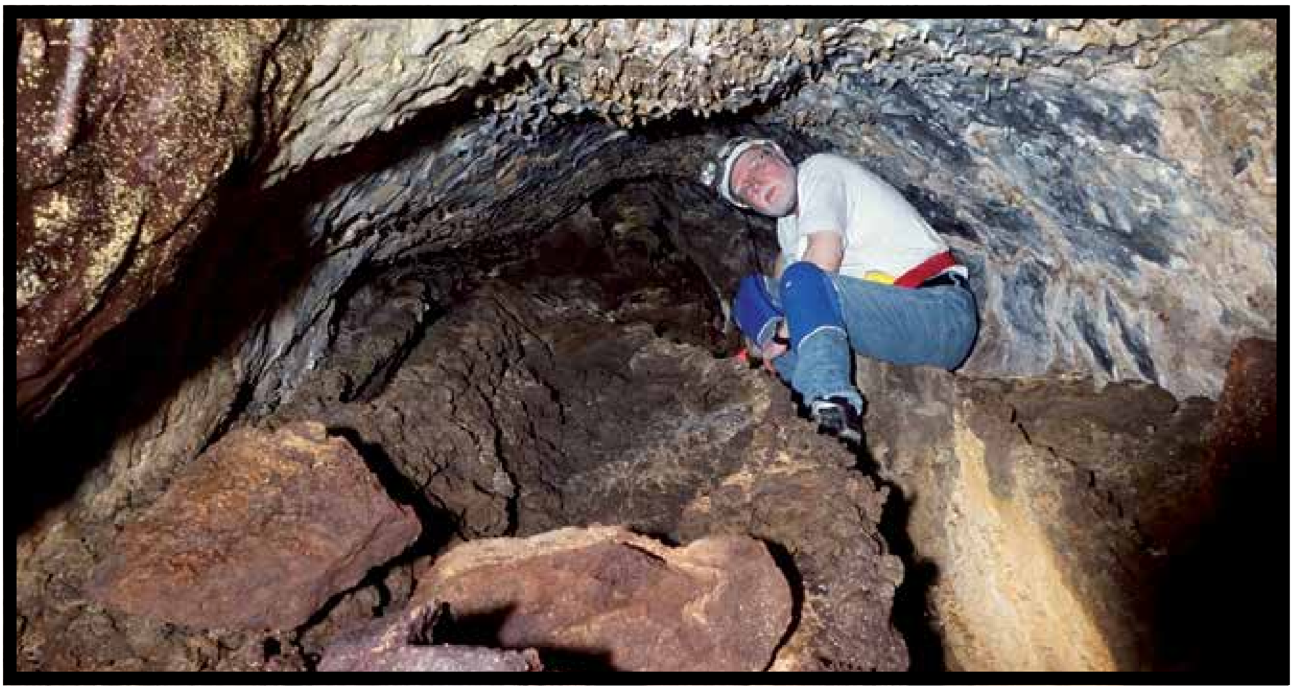
Greg Middleton

Stephan Kempe *Greg Middleton*

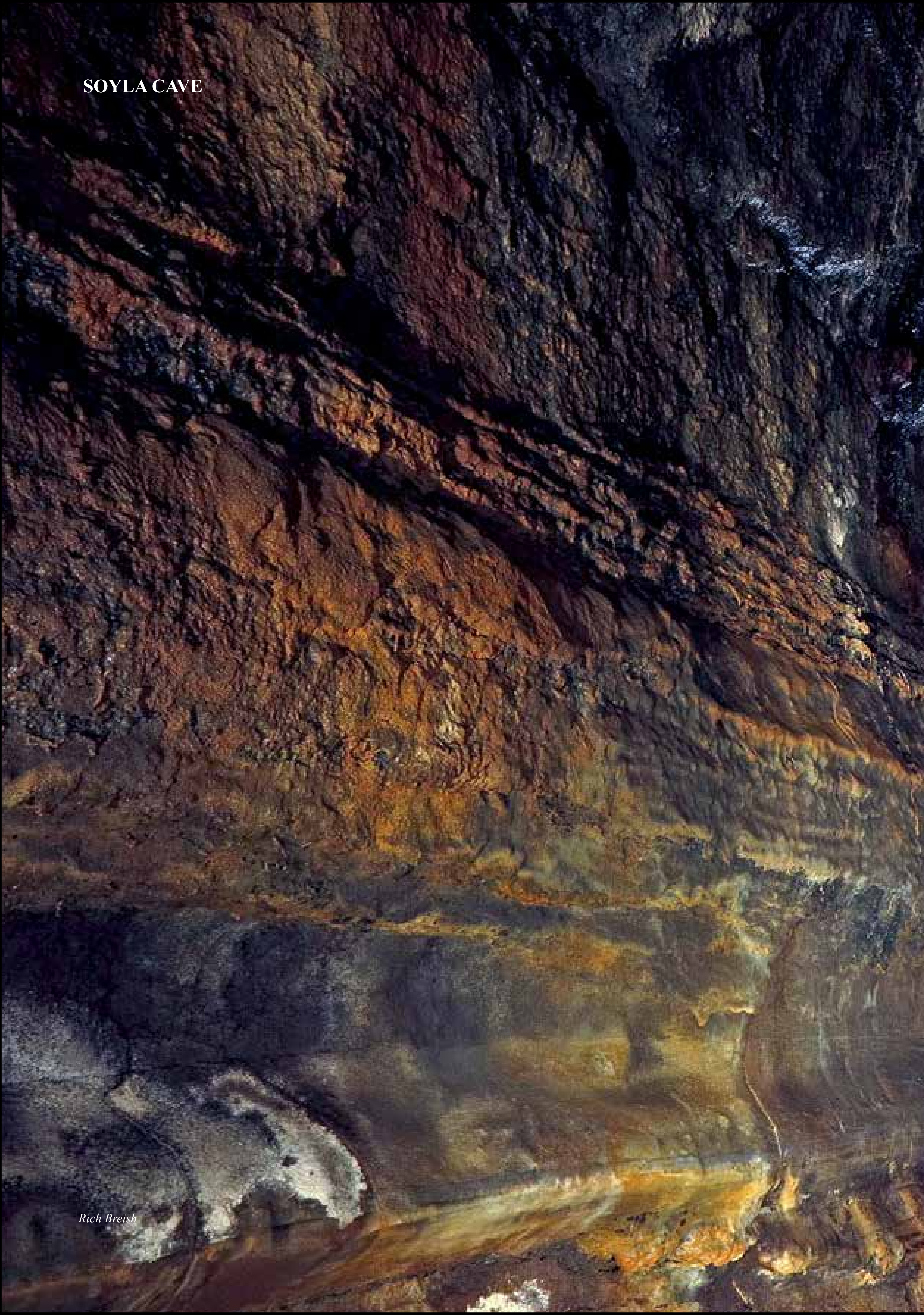
Plowman and Butler *Greg Middleton*



Rojas, Guhr, Toulkeridis, Gallardo, Plowman, Butler *Greg Middleton*

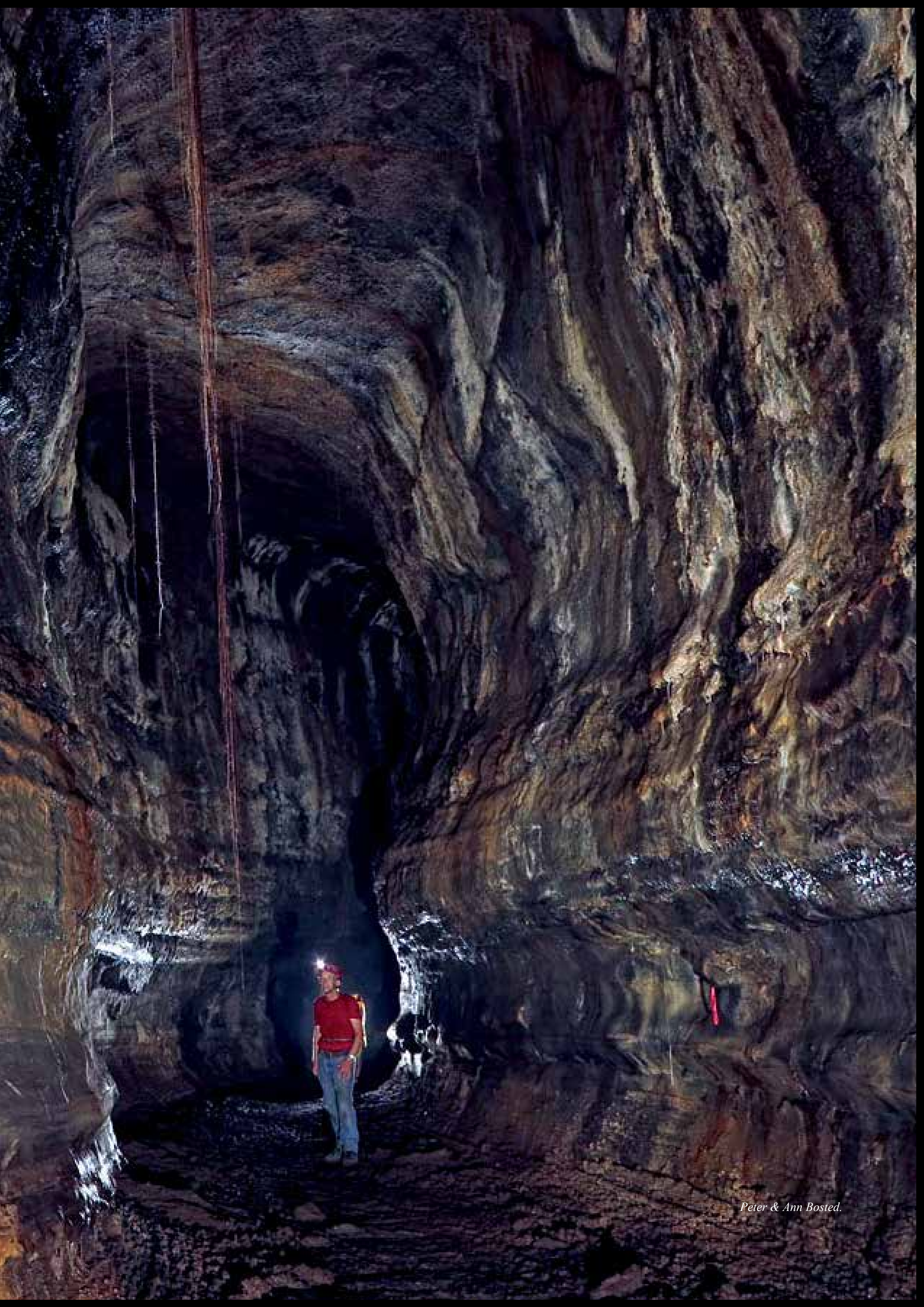


Stephan Kempe *Greg Middleton*



SOYLA CAVE

Rich Breish



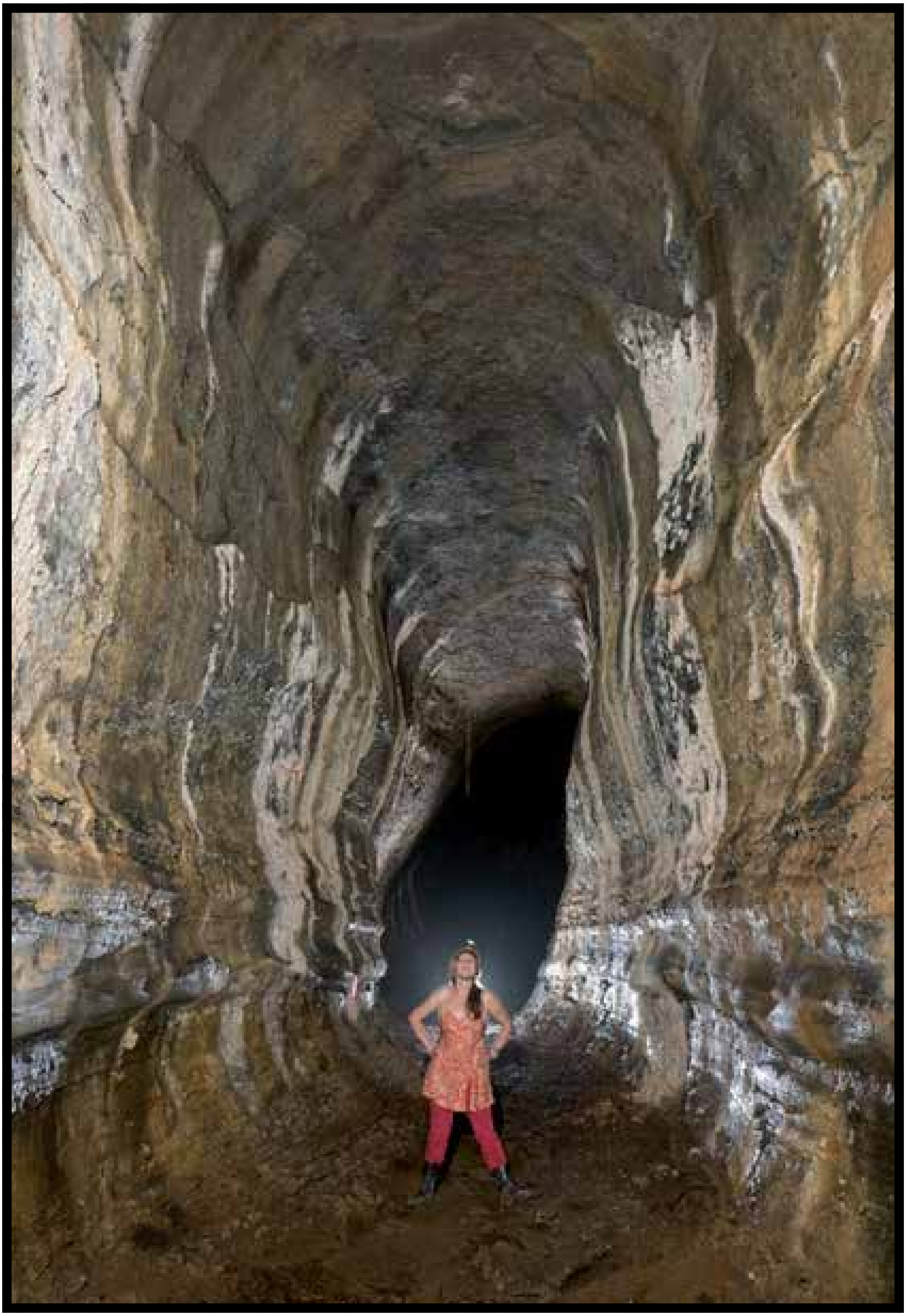
Peter & Ann Bosted.

SOYLA CAVE

Livia Gallardo *Dave Bunnell*

Livia Gallardo *Dave Bunnell*

SOYLA CAVE



Livia Gallardo *Dave Bunnell*

Symposium participants

Symposium participants

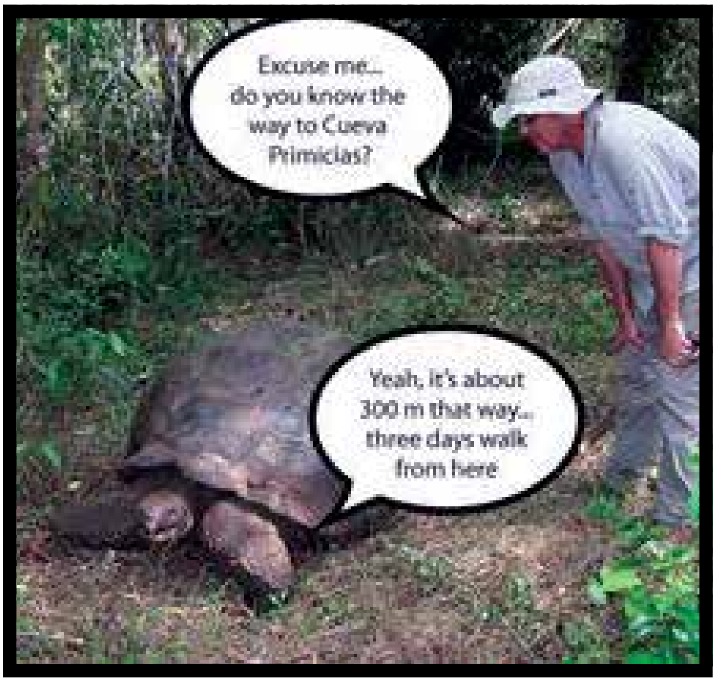
Symposium participants

Wednesday 19th of March

7.00 a.m. Breakfast at Hotel Flamingo

8.30 a.m. Bus transport from hotels towards Chato. Lunchbox distribution in the bus (entrance).

Caves at Premicias, Chato and Tortuga Crossing and surrounding Visit of eight caves (up to 800m). Division in three groups, rotation during day, guiding by Aaron and Galápagos team-members.



Theodora Rudolph

Phil Collett

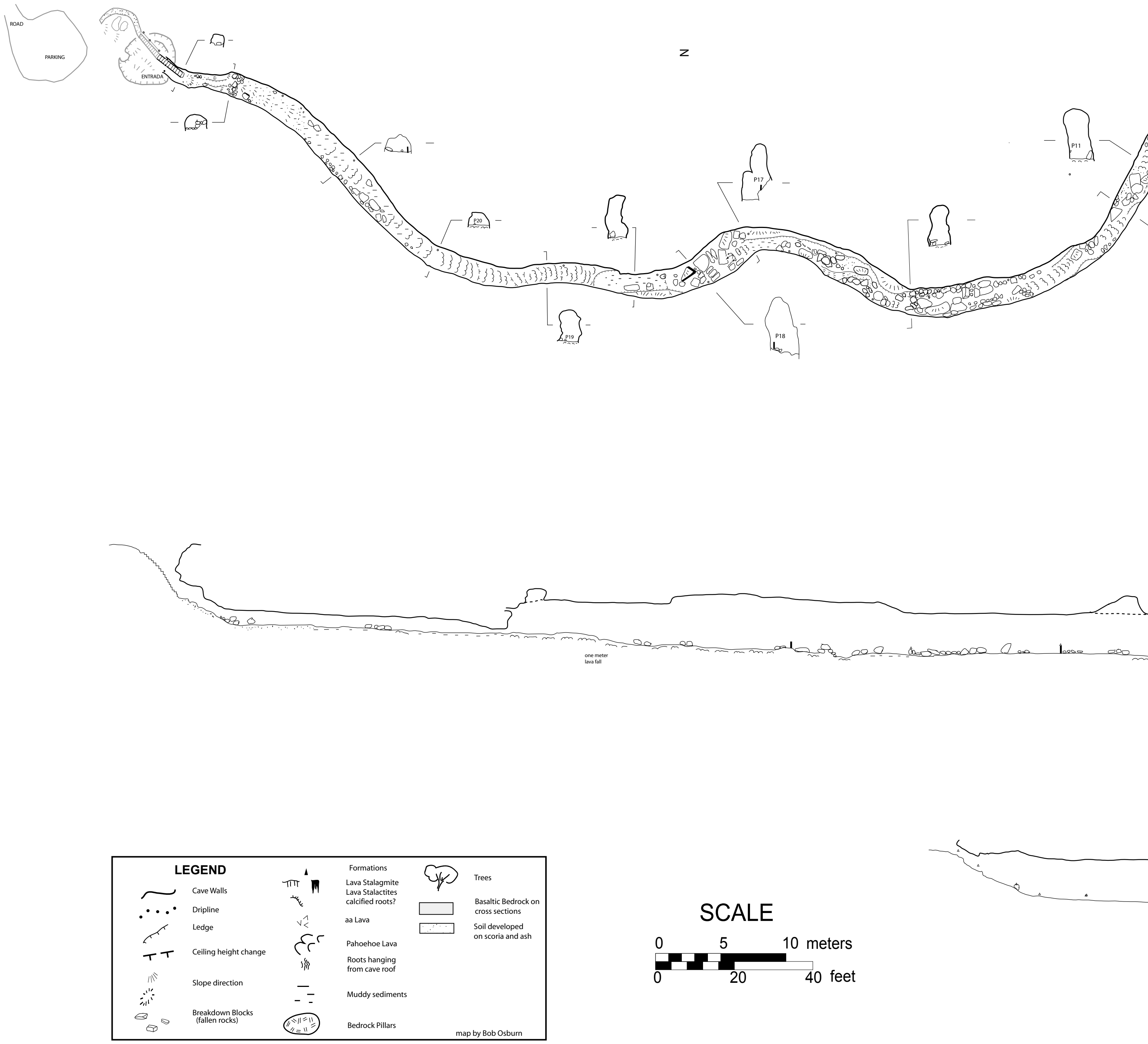
Dave Bunnell

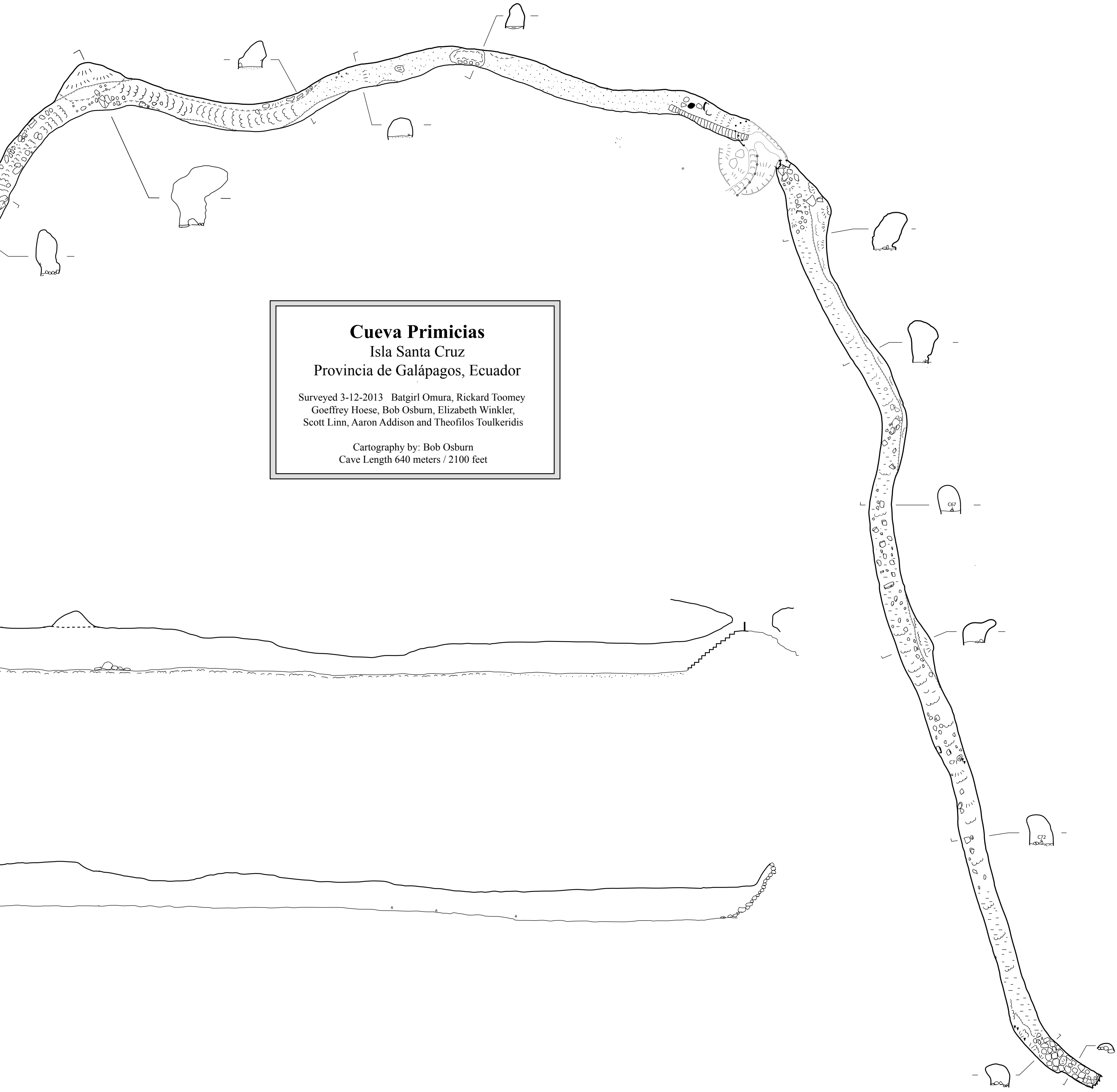
Geoff Hoese

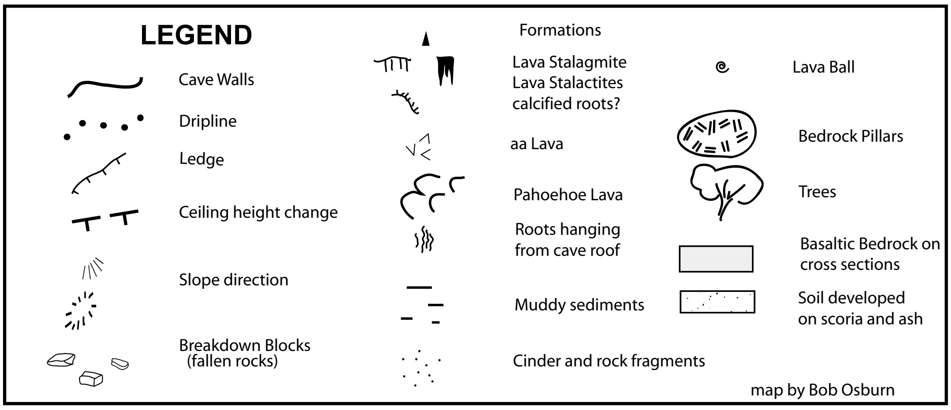
Geoff Hoese

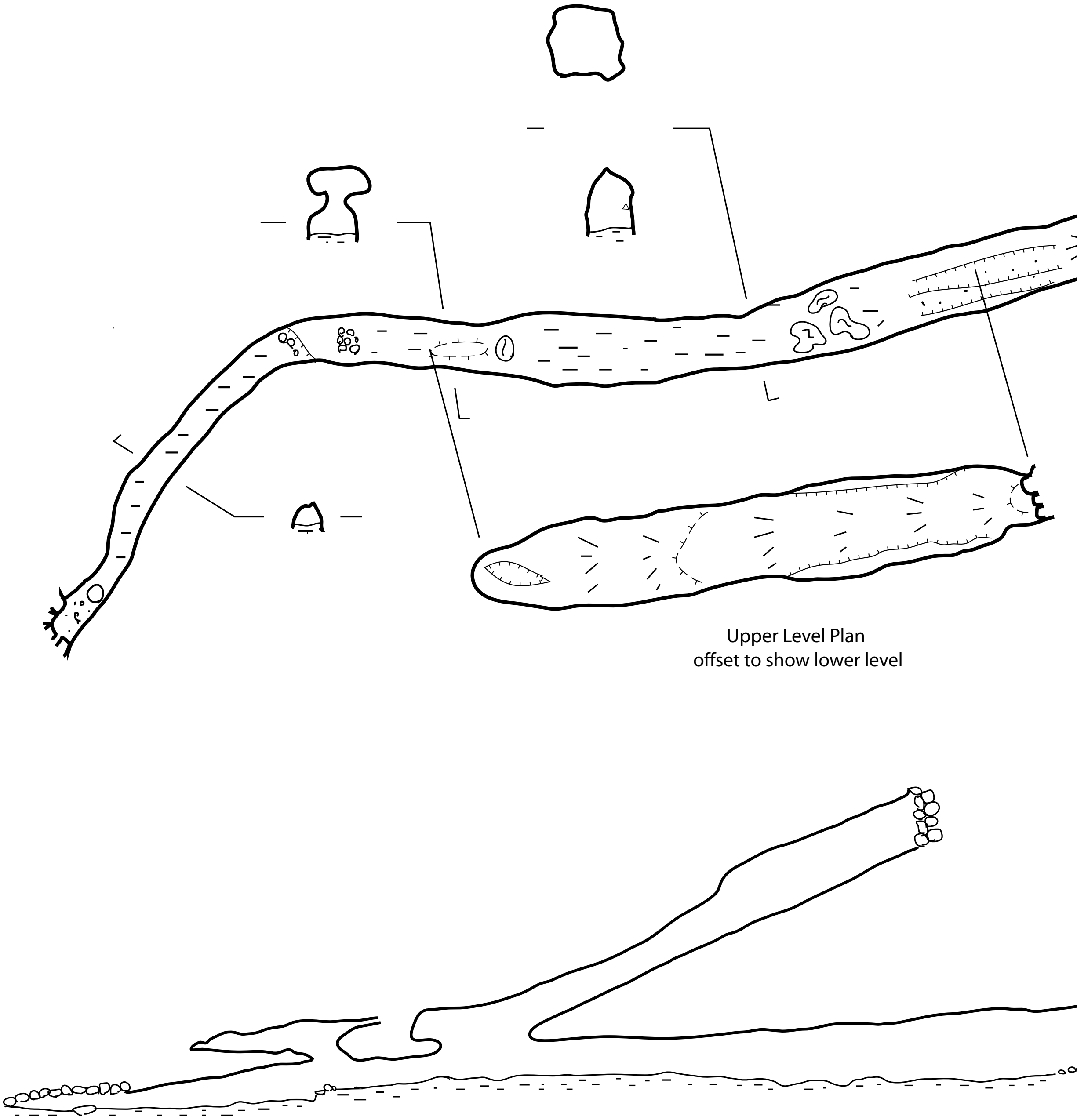
Geoff Hoese

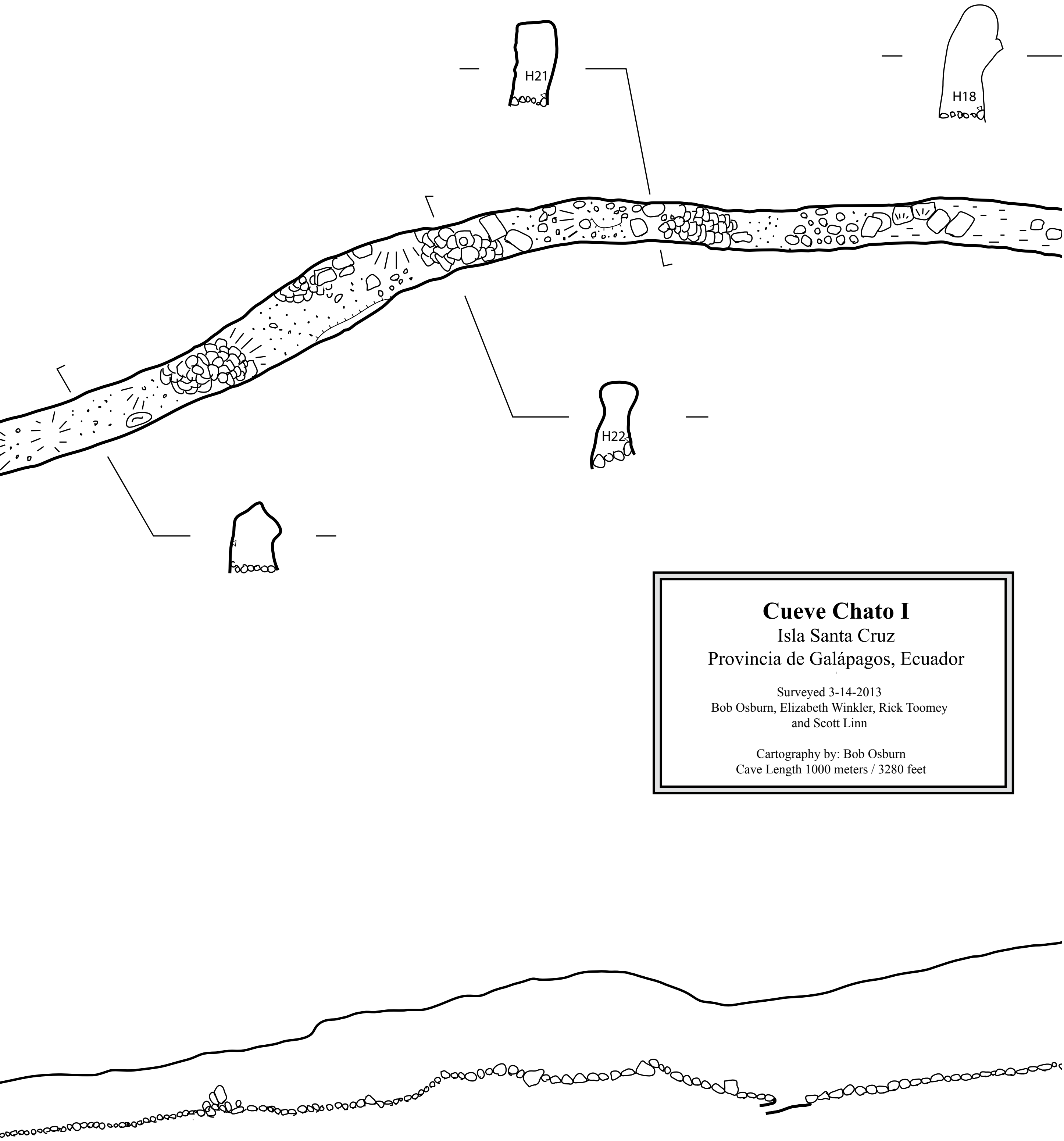
Jenny Kuo *Maximillian Dornseif*


ROAD
PARKING
ENTRADA
N
P20
P19
P17
P18
P11
one meter
lava fall
LEGEND
Cave Walls
Dripline
Ledge
Ceiling height change
Slope direction
Breakdown Blocks
(fallen rocks)
Formations
Lava Stalagmite
Lava Stalactites
calcified roots?
aa Lava
Pahoehoe Lava
Roots hanging
from cave roof
Muddy sediments
Bedrock Pillars
Trees
Basaltic Bedrock on
cross sections
Soil developed
on scoria and ash
map by Bob Osburn
SCALE
0 5 10 meters
0 20 40 feet


Cueva Primicias
Isla Santa Cruz
Provincia de Galápagos, Ecuador
Surveyed 3-12-2013 Batgirl Omura, Rickard Toomey
Goeffrey Hoese, Bob Osburn, Elizabeth Winkler,
Scott Linn, Aaron Addison and Theofilos Toulkeridis
Cartography by: Bob Osburn
Cave Length 640 meters / 2100 feet


LEGEND
Cave Walls
Dripline
Ledge
Ceiling height change
Slope direction
Breakdown Blocks
(fallen rocks)
Formations
Lava Stalagmite
Lava Stalactites
calcified roots?
aa Lava
Pahoehoe Lava
Roots hanging
from cave roof
Muddy sediments
Cinder and rock fragments
Lava Ball
Bedrock Pillars
Trees
Basaltic Bedrock on
cross sections
Soil developed
on scoria and ash
map by Bob Osburn


Upper Level Plan
offset to show lower level



Cueve Chato I

Isla Santa Cruz

Provincia de Galápagos, Ecuador

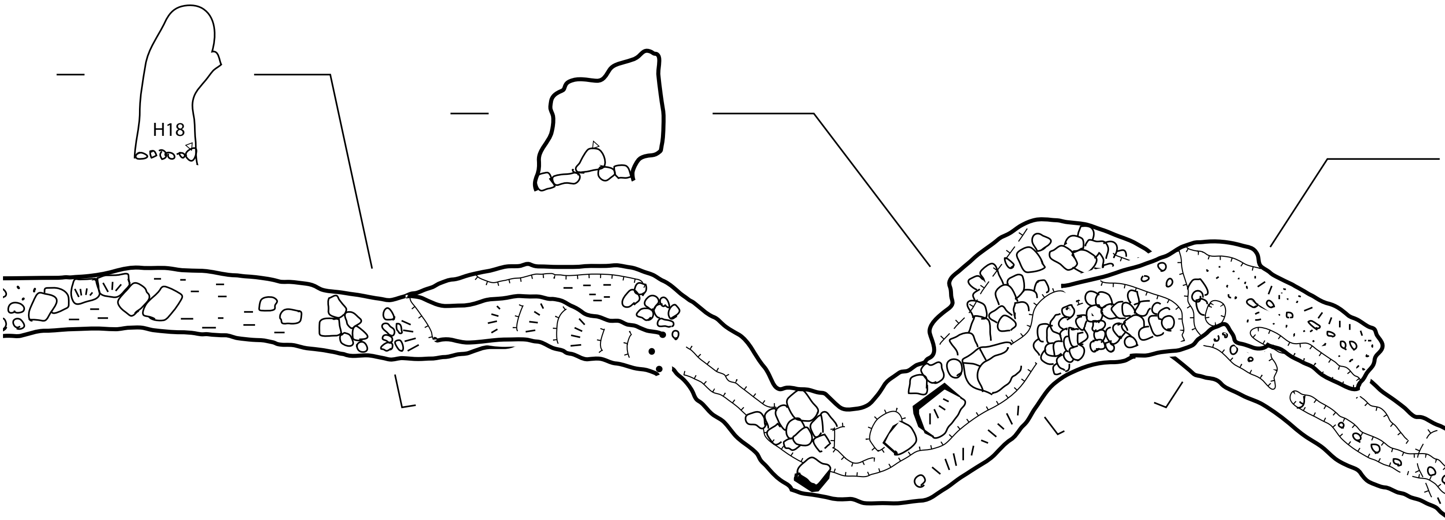
Surveyed 3-14-2013

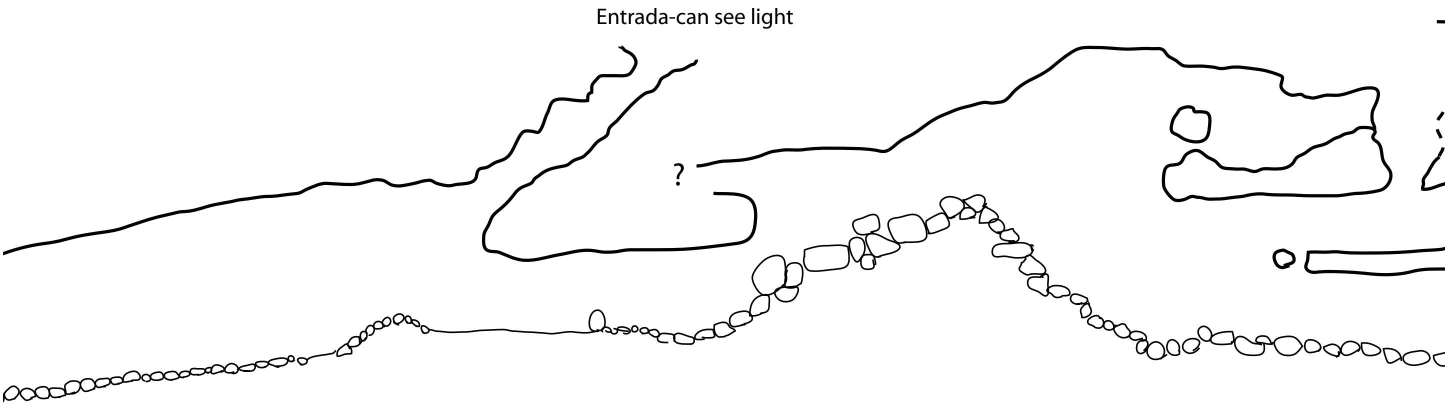
Bob Osburn, Elizabeth Winkler, Rick Toomey

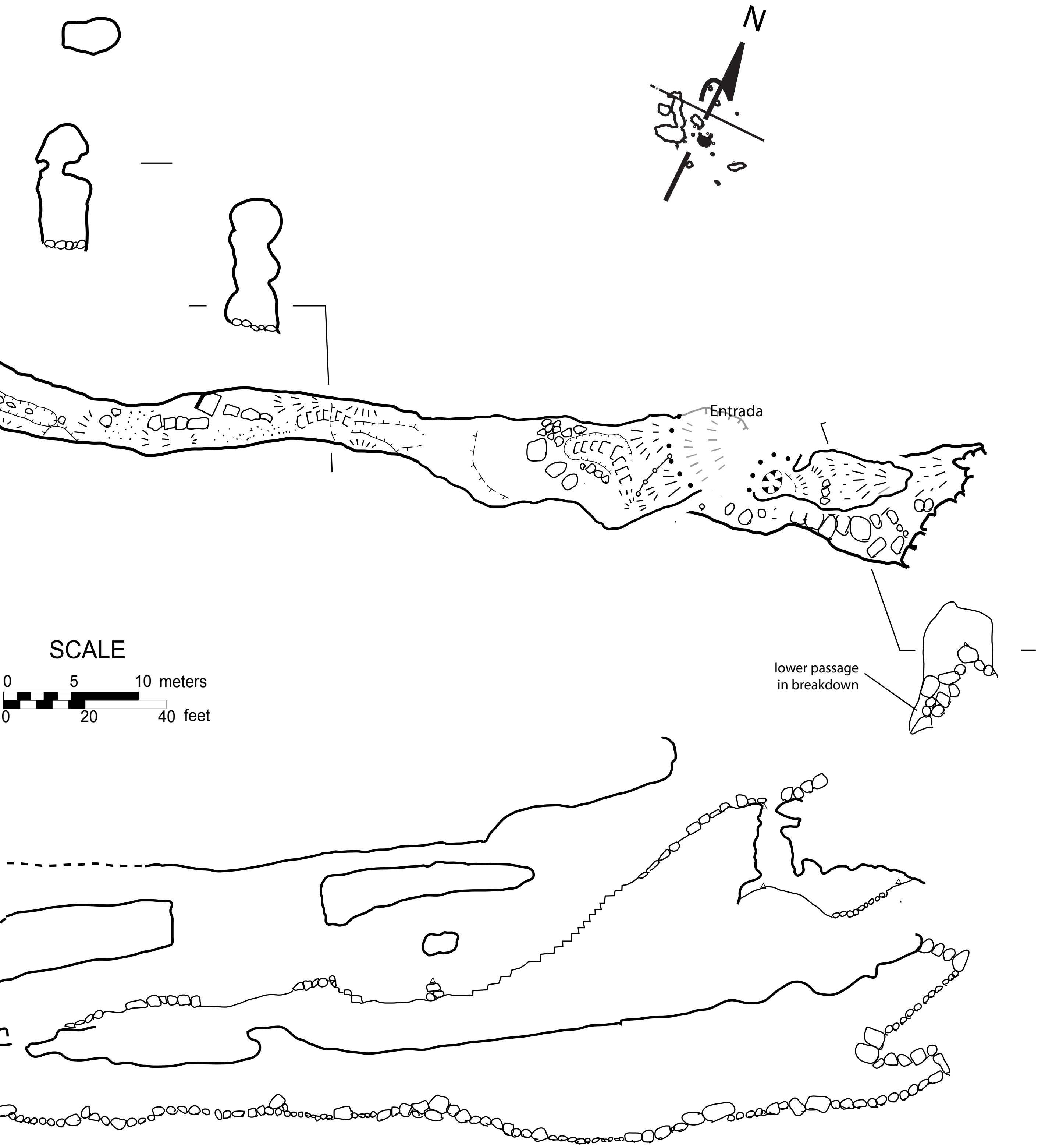
and Scott Linn

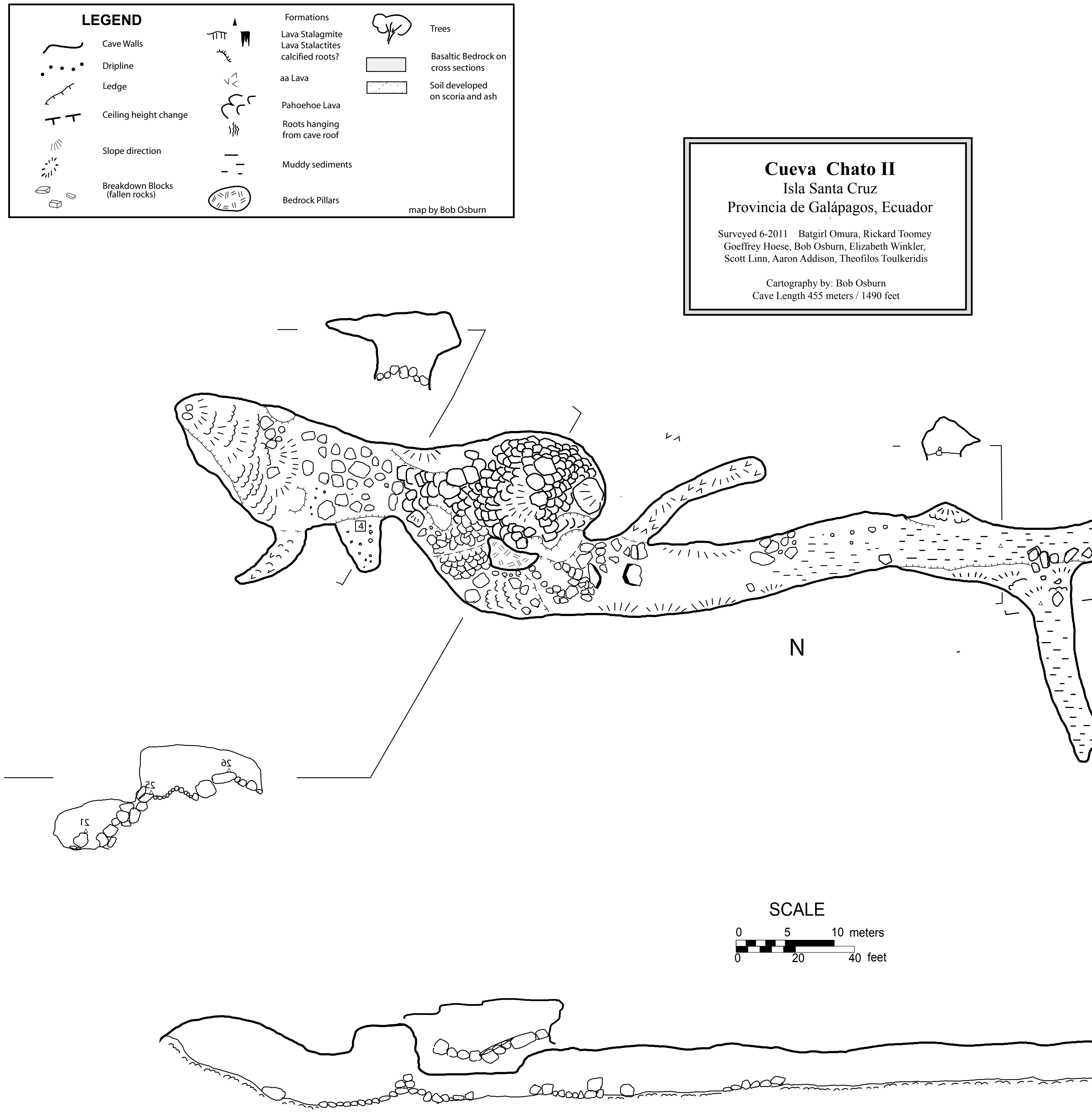
Cartography by: Bob Osburn

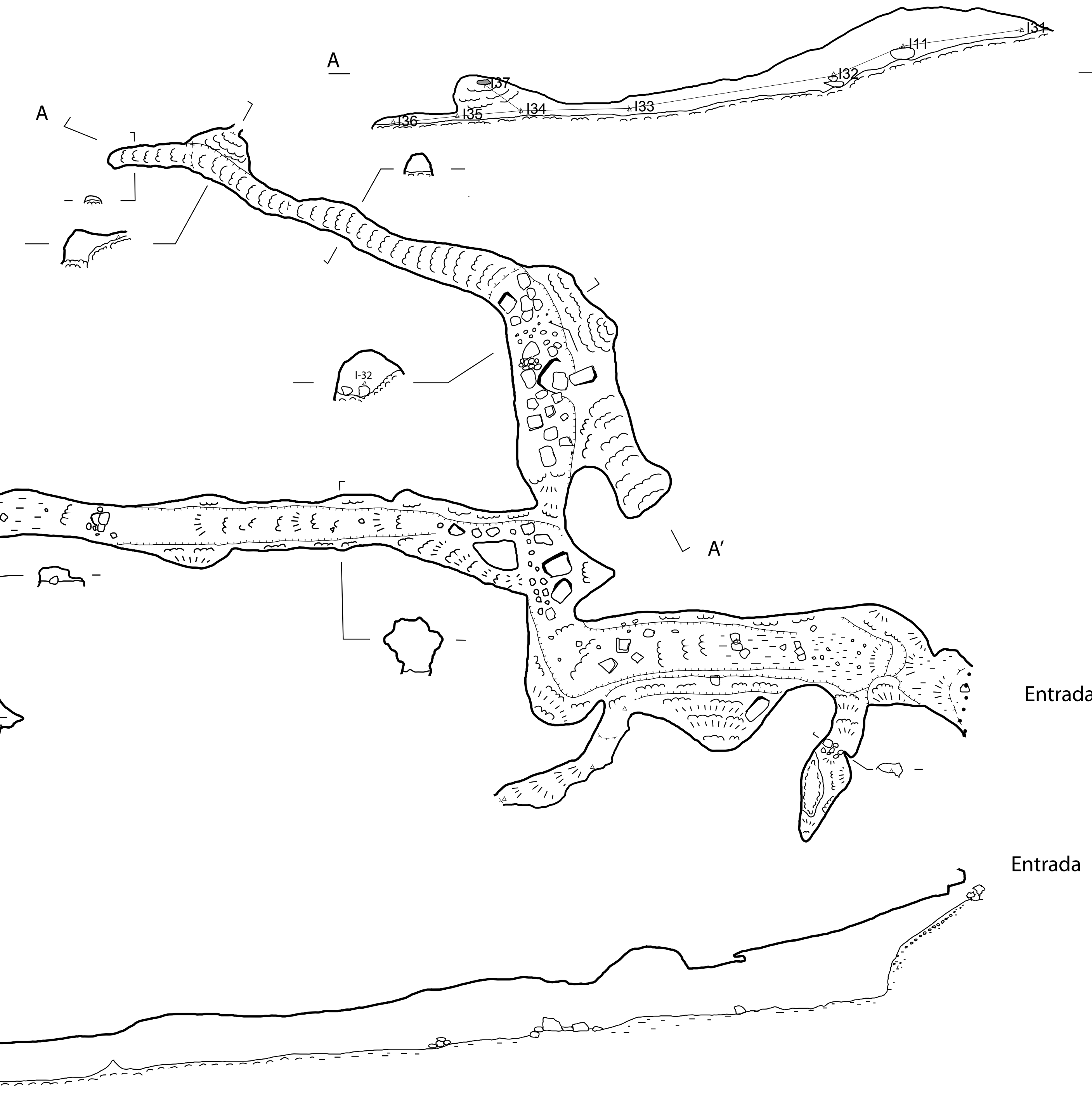
Cave Length 1000 meters / 3280 feet


H18

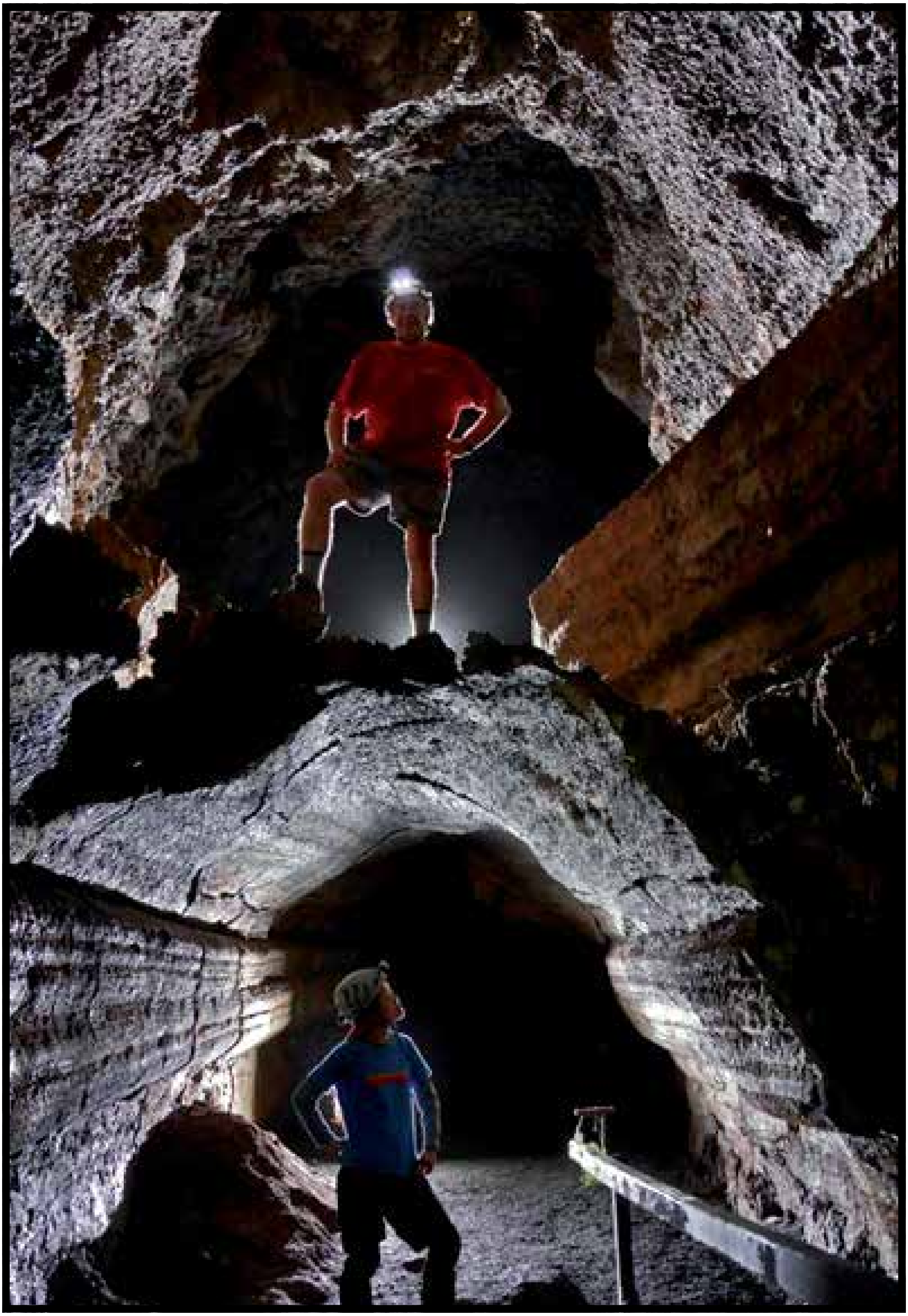

Entrada-can see light
?


N
Entrada
SCALE
0 5 10 meters
0 20 40 feet
lower passage
in breakdown


LEGEND
Cave Walls
Dripline
Ledge
Ceiling height change
Slope direction
Breakdown Blocks (fallen rocks)
Formations
Lava Stalagmite
Lava Stalactites
calcified roots?
aa Lava
Pahoehoe Lava
Roots hanging from cave roof
Muddy sediments
Bedrock Pillars
Trees
Basaltic Bedrock on cross sections
Soil developed on scoria and ash
map by Bob Osburn
Cueva Chato II
Isla Santa Cruz
Provincia de Galápagos, Ecuador
Surveyed 6-2011 Batgirl Omura, Rickard Toomey
Goeffrey Hoese, Bob Osburn, Elizabeth Winkler,
Scott Linn, Aaron Addison, Theofilos Toulkeridis
Cartography by: Bob Osburn
Cave Length 455 meters / 1490 feet
N
SCALE
0 5 10 meters
0 20 40 feet

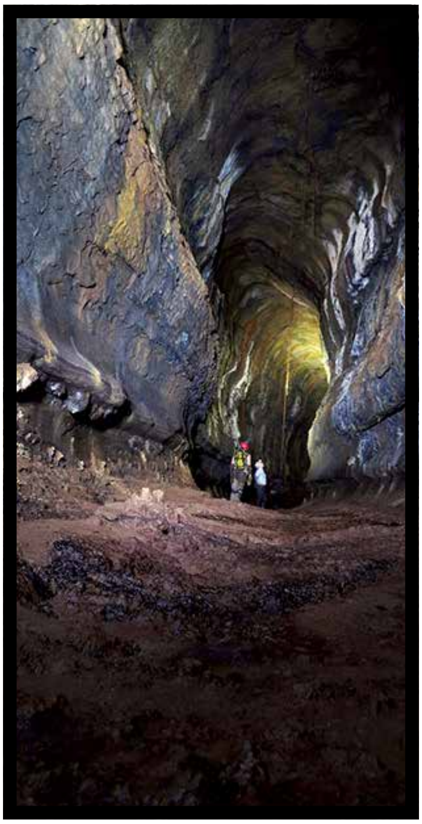

A
A'
I31
I11
I32
I37
I34
I33
I35
I36
A
I-32
A'
Entrada
Entrada

TURTLES CROSSING CAVE



Dave Bunnell

TURTLES CROSSING CAVE



Osburn, Linn and Toulkeridis "False Cascajo" cave in 2013 *Aaron Addison*

Rick Haley *Aaron Addison*

Theofilos Toulkeridis *Aaron Addison*

Rick Haley *Aaron Addison*

Greg Middleton

Greg Middleton

Stephan Kempe *Greg Middleton*

Symposium Participants

Symposium Participants

Symposium Participants

Symposium Participants

Symposium Participants

Symposium Participants

Symposium Participants

Symposium Participants

CHATO CAVE

Symposium participants *Phill Collett*

Phill Collett

CHATO CAVE

Phil Collett

Theofilos Toulkeridis

Theofilos Toulkeridis

Symposium participants

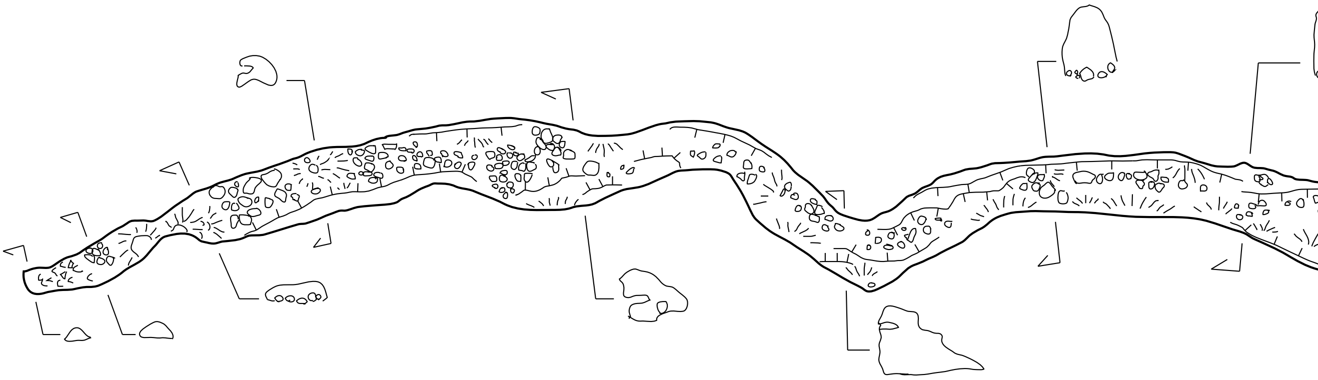
18.30 Dinner (Pizza) at Hernan

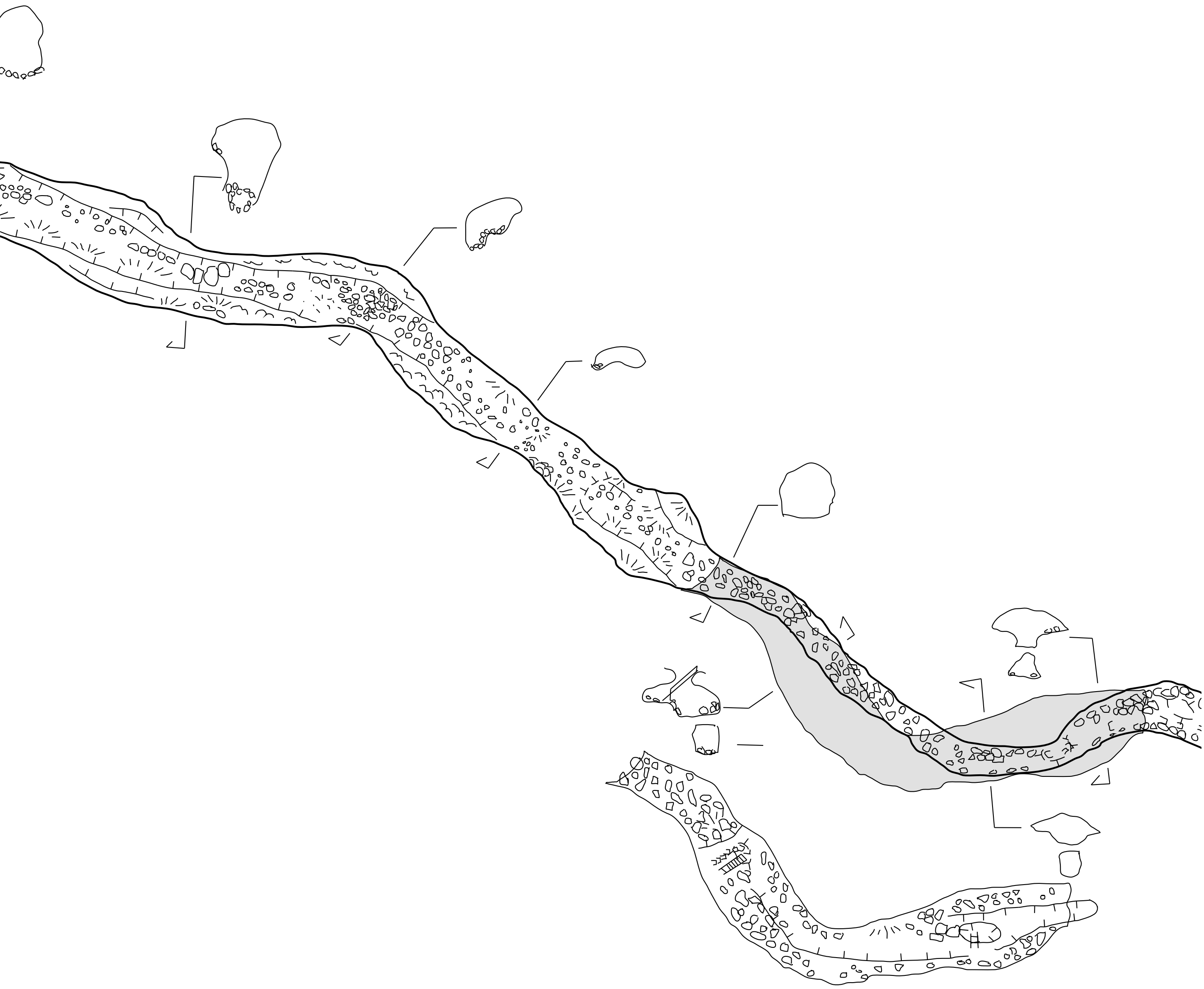
20.00 Transport to hotels

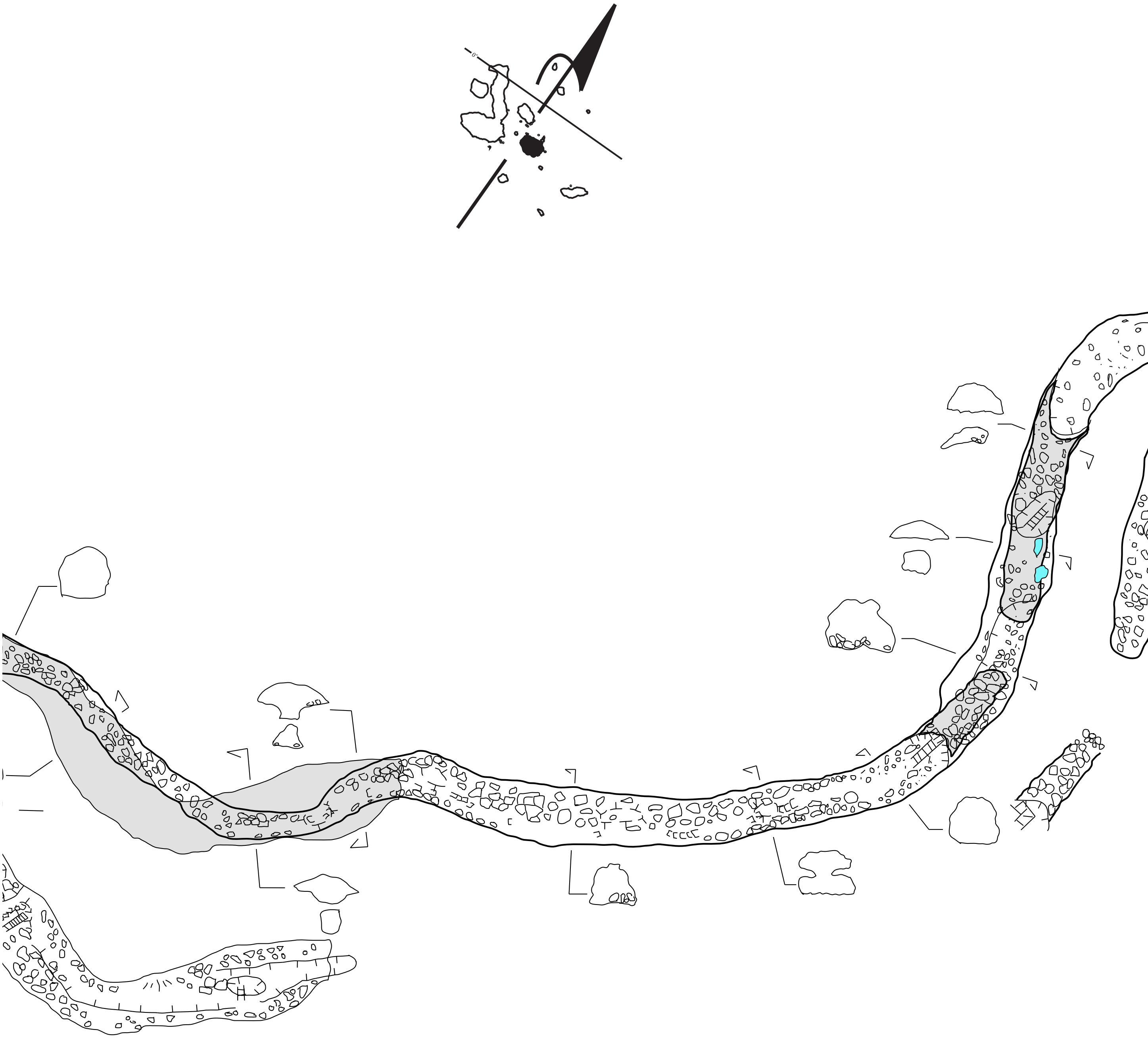
Thursday 20th of March

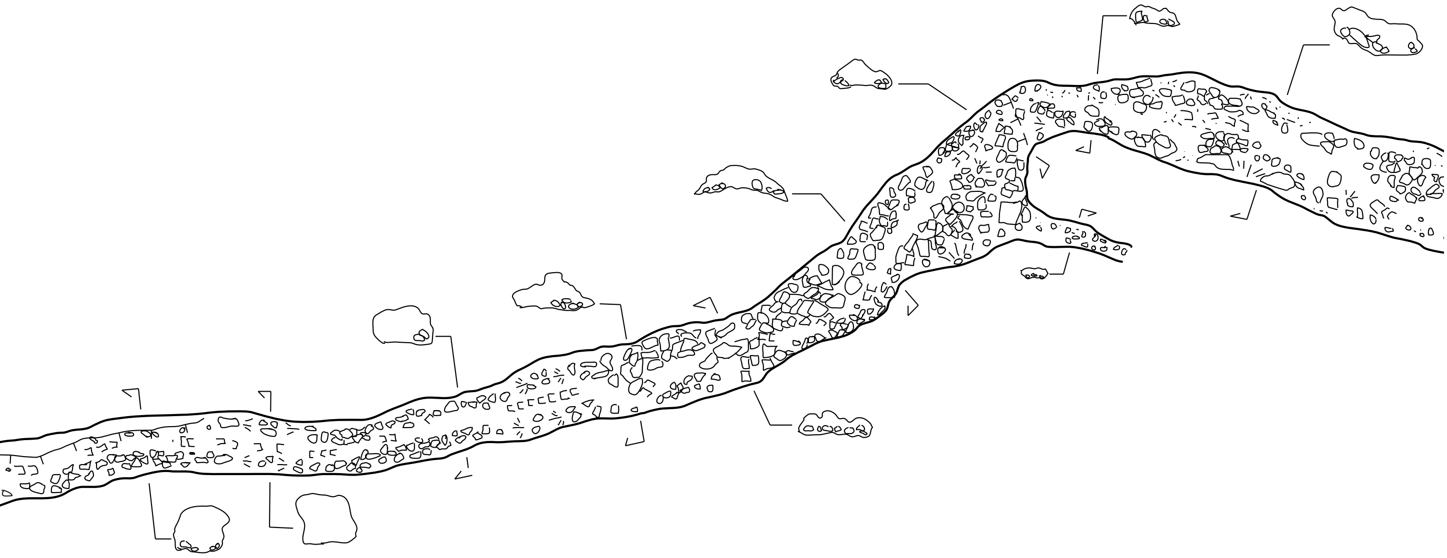
7.00 a.m. Breakfast at Hotel Flamingo Check-out of your hotel

8.30 a.m. Bus transport from hotels towards Royal Palm (without backpack, as you can leave it in the hotels). Lunchbox distribution in the bus (entrance). Royal Palm Cave (approx. 1000m), alltogether.









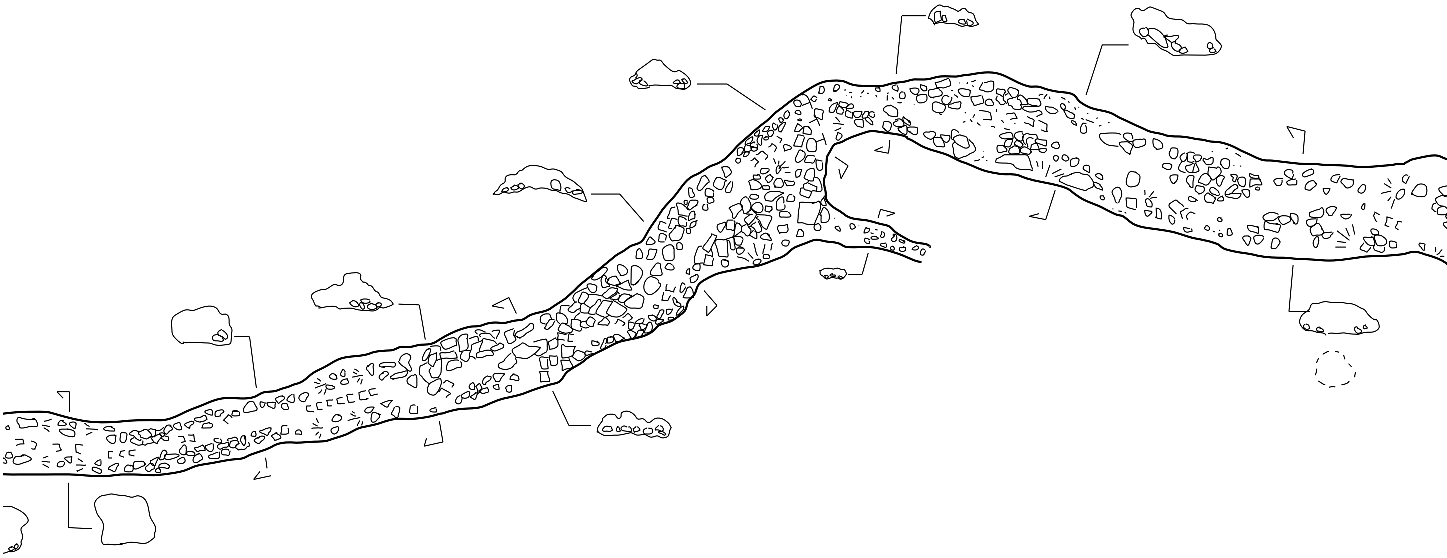
Cueva Royal Palm

Isla Santa Cruz

Provincia de Galápagos, Ecuador

Mapped by Rick Haley, Glenn Robert Osborn, Aaron Addison, Geoffrey Brian Hoese, Scott Linn, Rick Toomey, Elizabeth Winkler, Theofilos Toulkeridis, Batgirl Omura

Cartography by: Aaron Addison



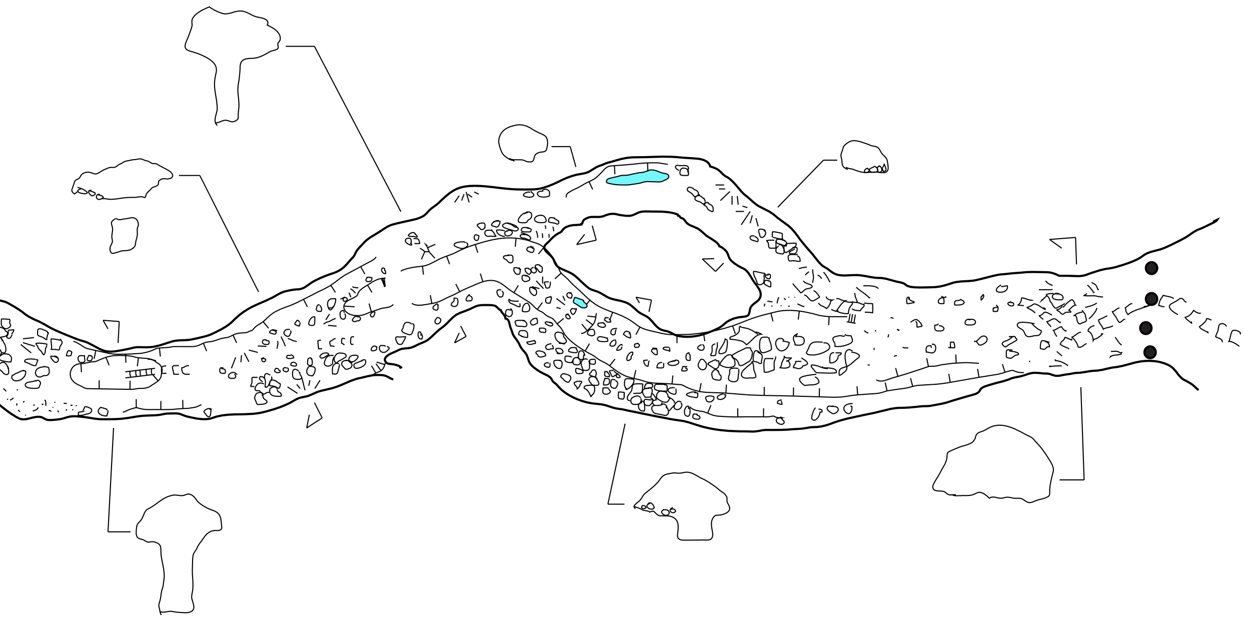
Cueva Royal Palm

Isla Santa Cruz

Provincia de Galápagos, Ecuador

Mapped by Rick Haley, Glenn Robert Osborn, Aaron Addison, Geoffrey Brian Hoese, Scott Linn, Rick Toomey, Elizabeth Winkler, Theofilos Toulkeridis, Batgirl Omura

Cartography by: Aaron Addison



Provisional Map

Cueva Royal Palm

Isla Santa Cruz, Galapagos Ecuador

Provisional Map

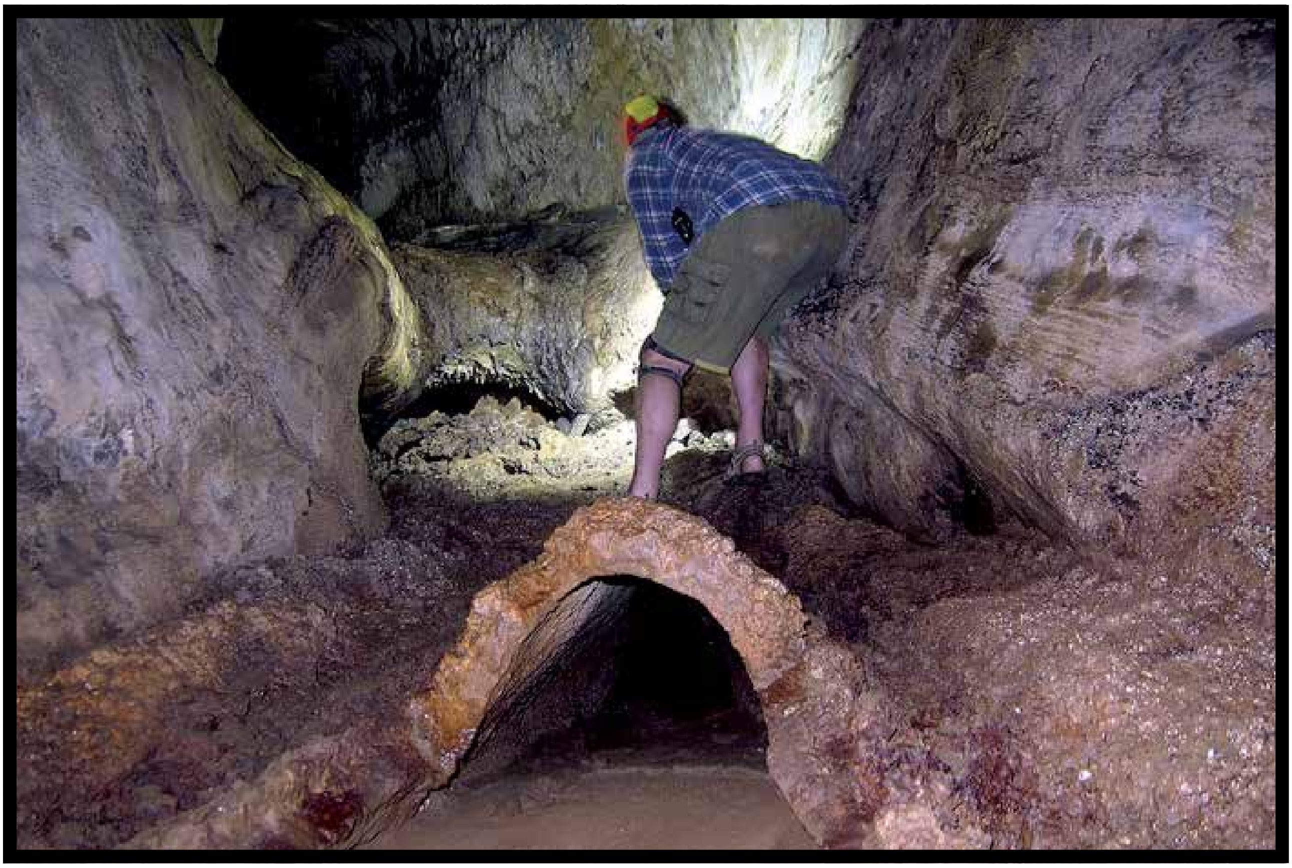
ROYAL PALM CAVE

Phil Collett

Phil Collett

Theofilos Toulkeridis

ROYAL PALM CAVE



Phil Collett

13.00 Bus towards hotels, walk to Port (boat). Boat-transfer to Isabela Island, Arrivals and accommodation in three different hotels, programmed chaos….

19.00 Dinner

The Spanish Group: Raquel Daza Brunet, Manuel Guerrero, Asunción Galera, José Maria Calaforra Chordi *Raquel Daza Brunet*

Raquel Daza Brunet enjoying a lovely lobster

Raquel Daza Brunet

Friday 21st of March

7.00 a.m. Breakfast at own Hotel

8.30 a.m. Transport from hotels towards different caves. Lunchbox distribution in the bus (entrance).

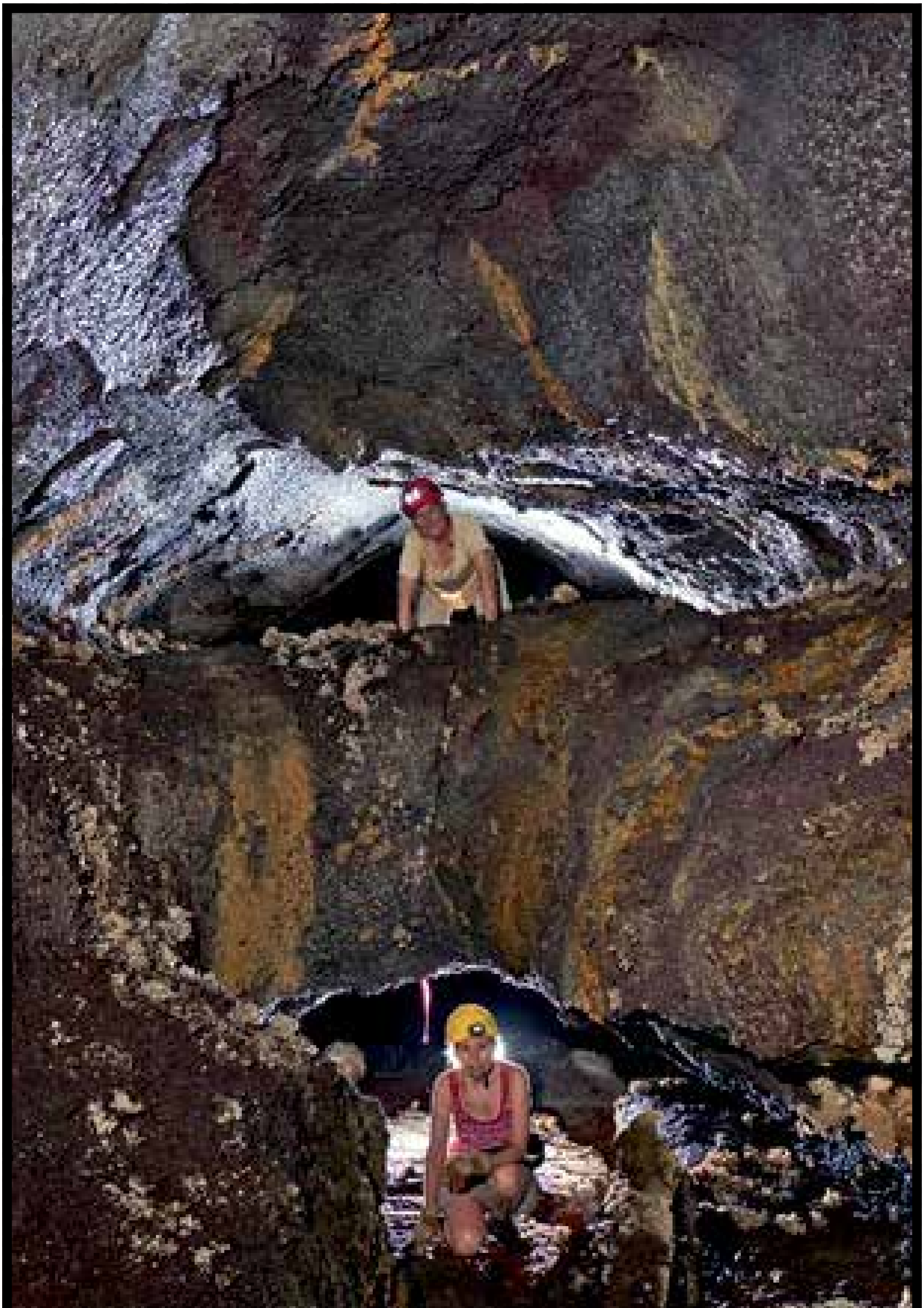
Distribution at caves “Triple Volcán”, “Sucre”, “Cueva Estero”, leaded by various members. Rotation during the day. Lunch at the same restaurant of last evening. Return to hotel at different times.

19.30 Farewell Dinner at Hansen

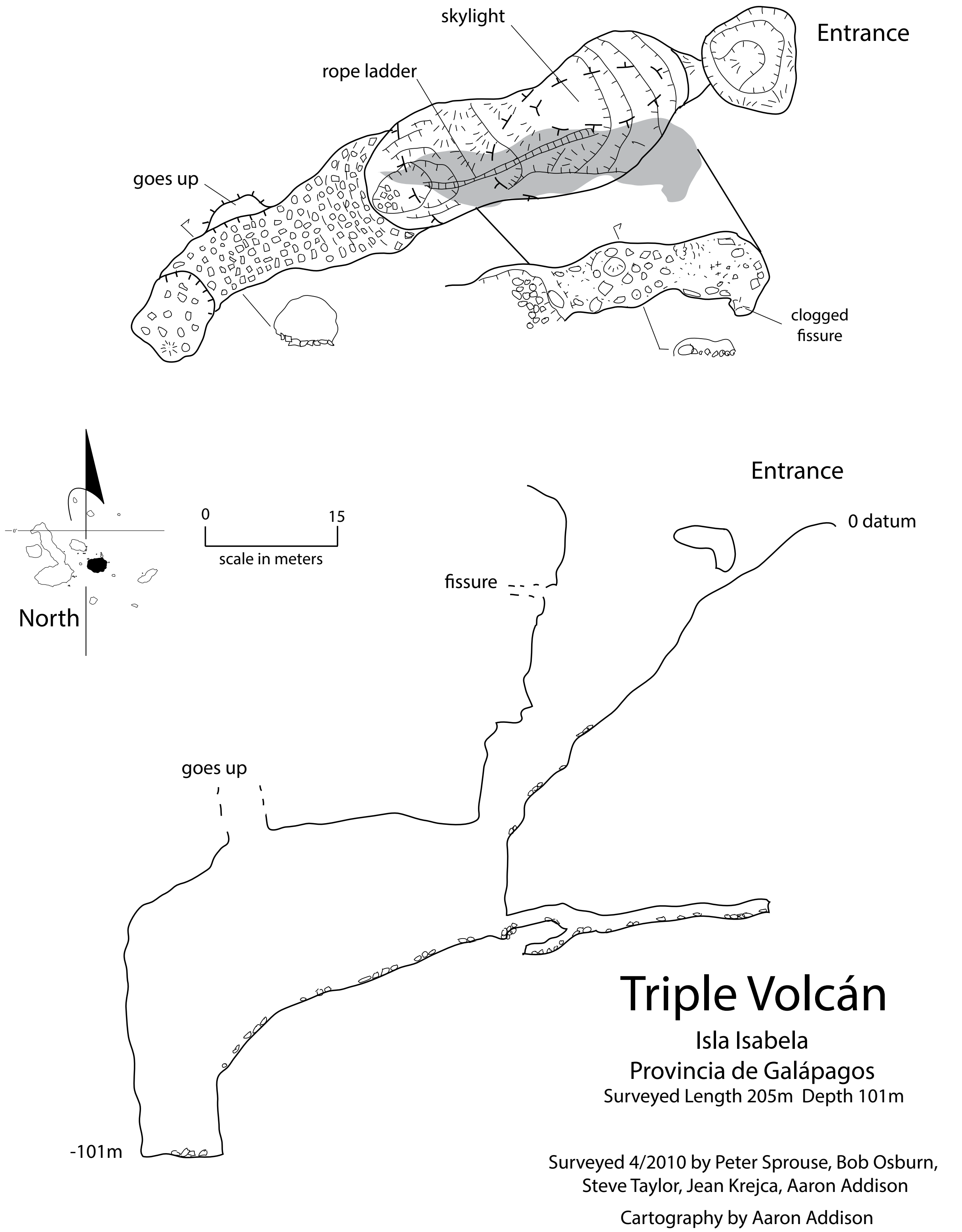
ROYAL PALM CAVE

Dave Bunnell

Dave Bunnell



Dave Bunnell



Triple Volcán

Isla Isabela
Provincia de Galápagos
Surveyed Length 205m Depth 101m

Surveyed 4/2010 by Peter Sprouse, Bob Osburn, Steve Taylor, Jean Krejca, Aaron Addison

Cartography by Aaron Addison

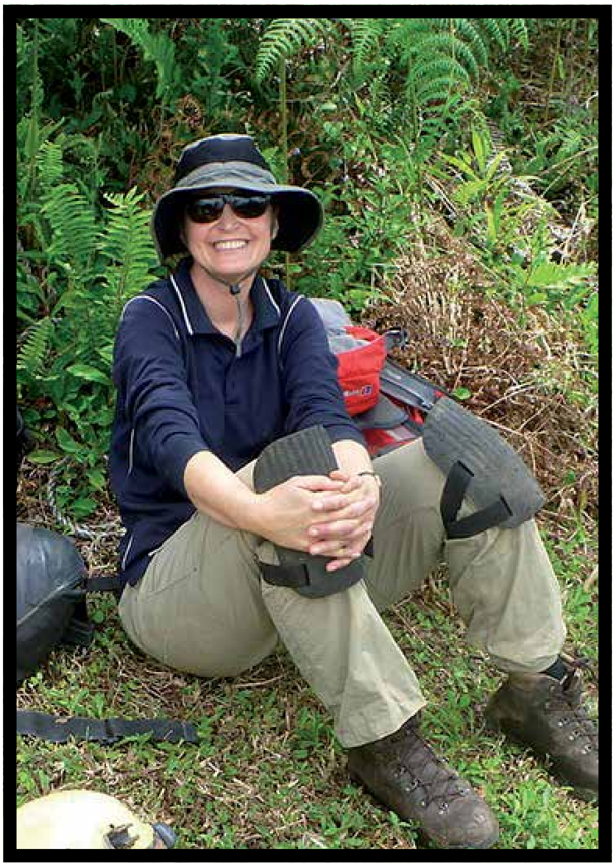
standard NSS map symbols

TRIPLE VOLCAN CAVE

Bob Osburn *Peter Sprouse*

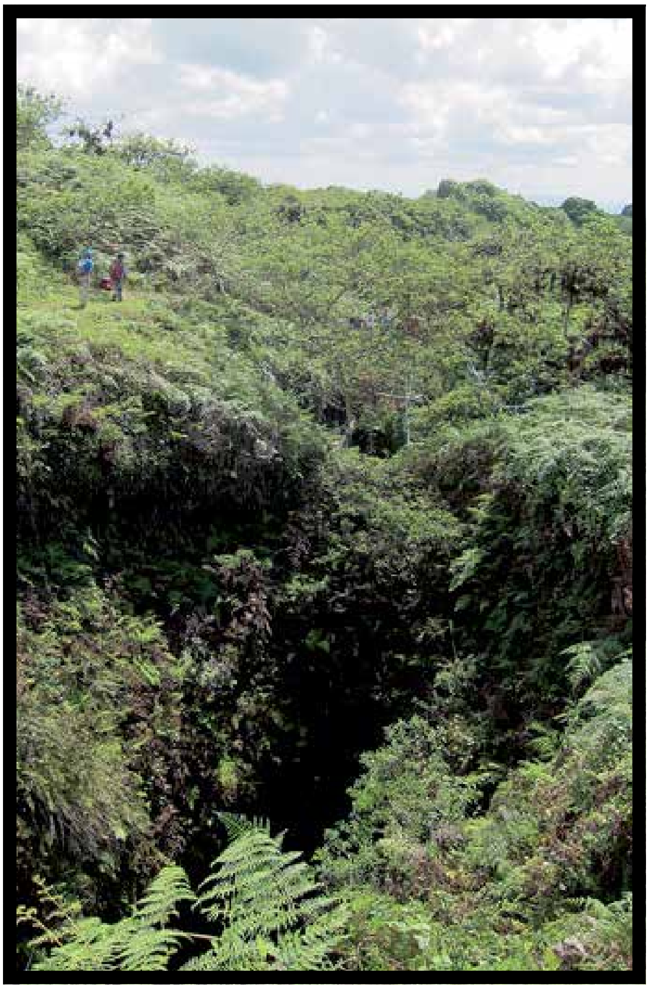
Phil Collett

Valrie Arriel Hildreth-Werker Julia James



Cathie Plowman Julia James

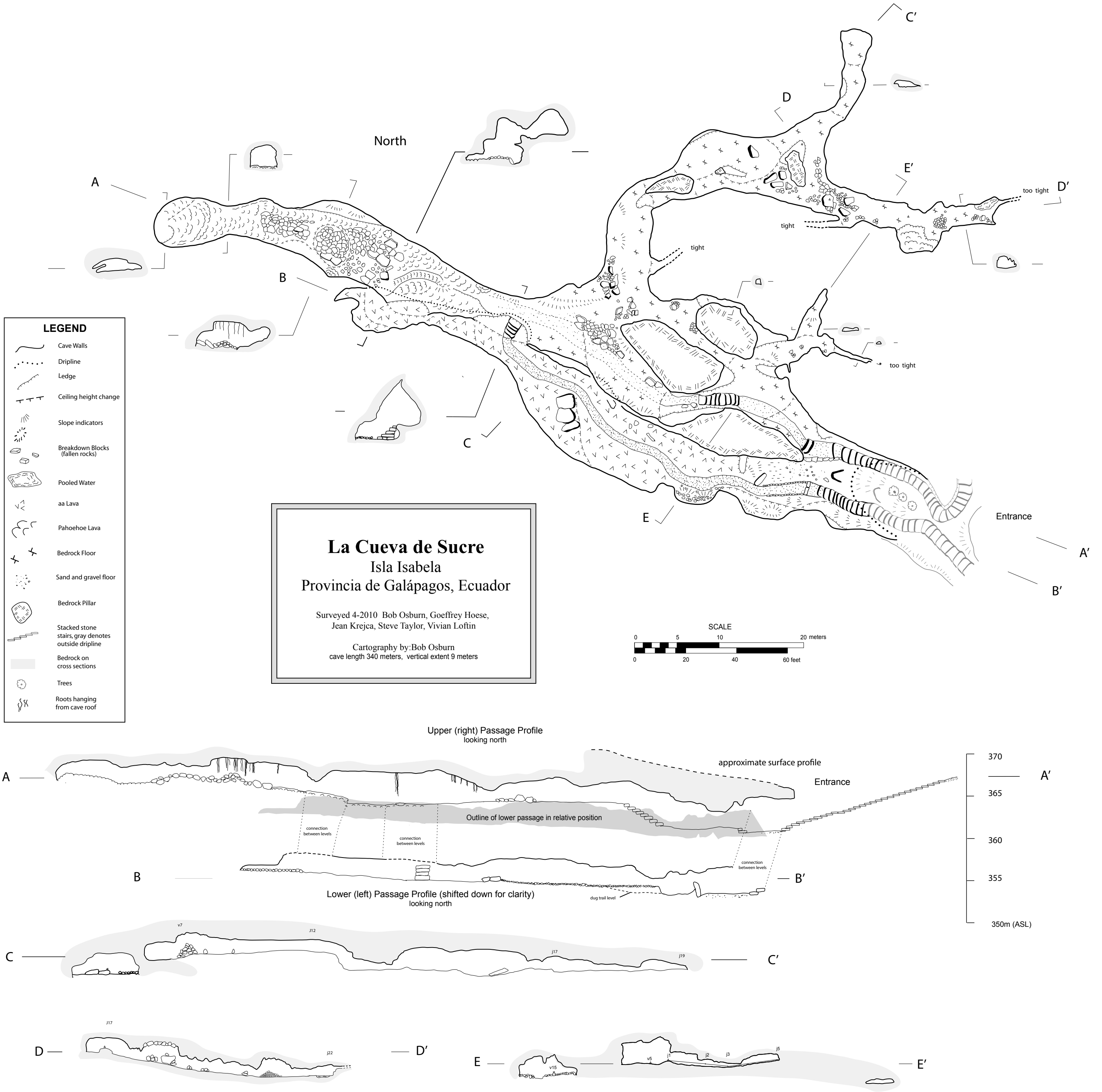
Phil Collett

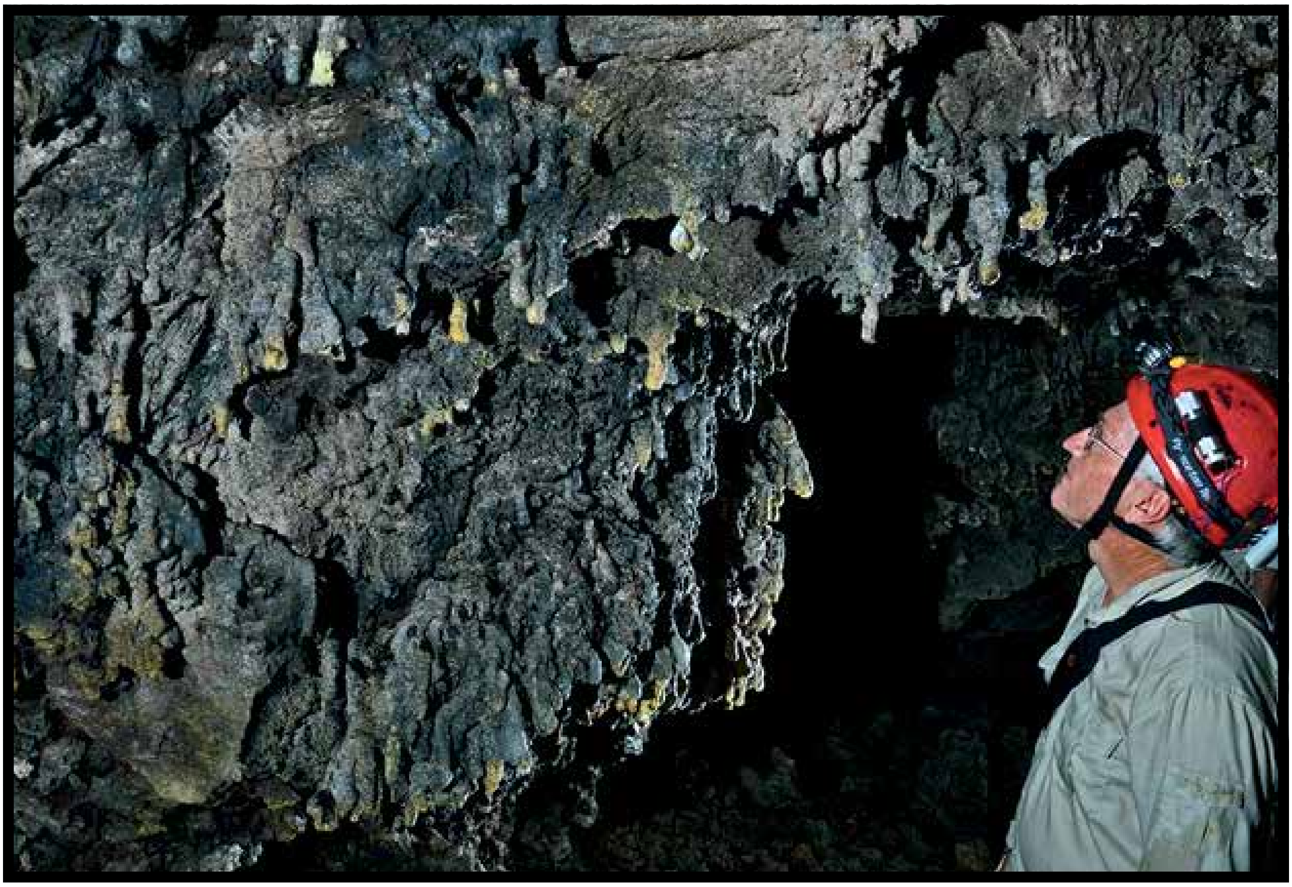


Phil Collett

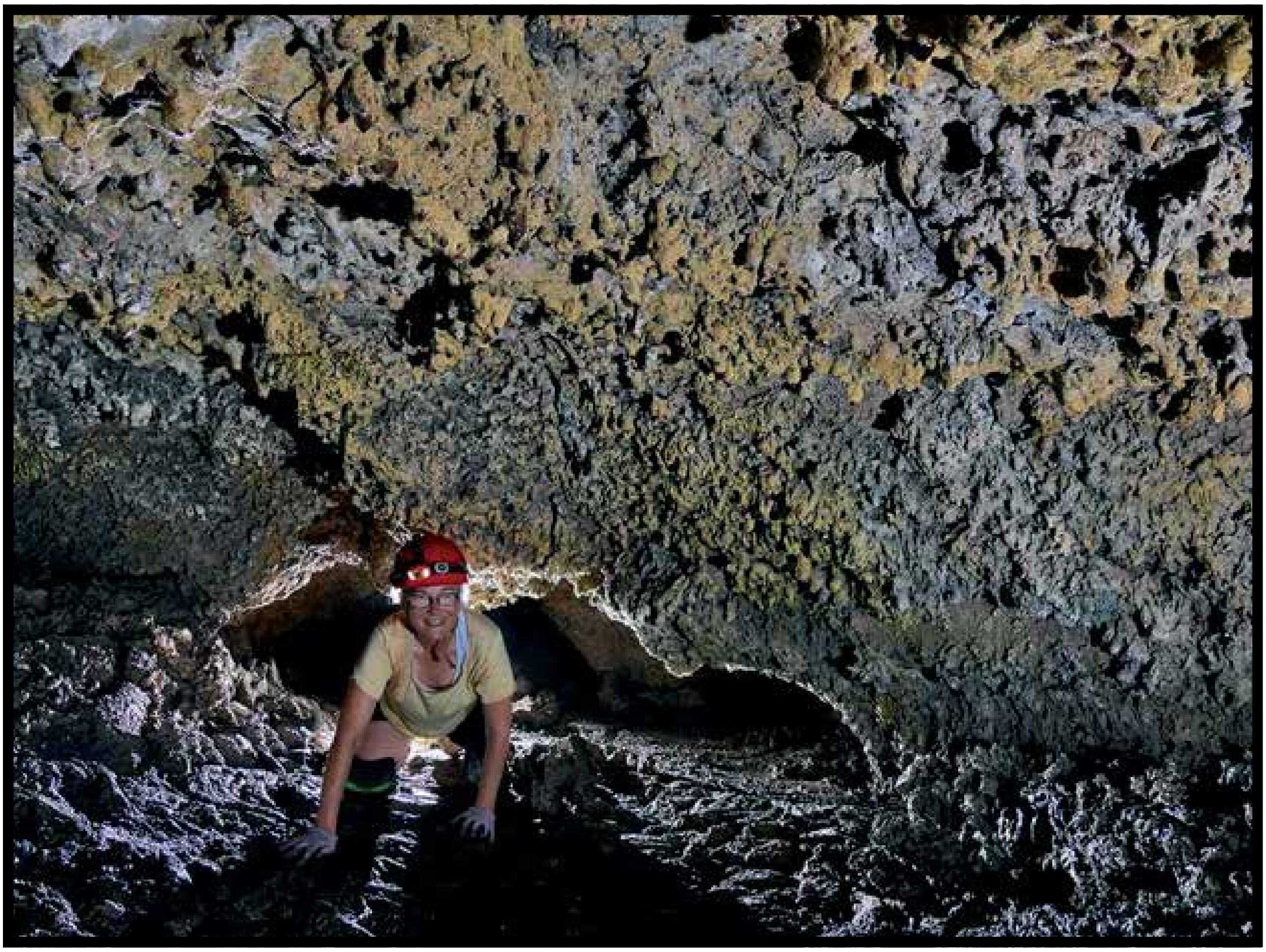
Phil Collett

SUCRE CAVE


North
A
A′
B
B′
C
C′
D
D′
E
E′
tight
too tight
Entrance
LEGEND
Cave Walls
Dripline
Ledge
Ceiling height change
Slope indicators
Breakdown Blocks (fallen rocks)
Pooled Water
aa Lava
Pahoehoe Lava
Bedrock Floor
Sand and gravel floor
Bedrock Pillar
Stacked stone stairs, gray denotes outside dripline
Bedrock on cross sections
Trees
Roots hanging from cave roof
La Cueva de Sucre
Isla Isabela
Provincia de Galápagos, Ecuador
Surveyed 4-2010 Bob Osburn, Goeffrey Hoese, Jean Krejca, Steve Taylor, Vivian Loftin
Cartography by:Bob Osburn
cave length 340 meters, vertical extent 9 meters
SCALE
0 5 10 20 meters
0 20 40 60 feet
Upper (right) Passage Profile
looking north
approximate surface profile
Entrance
Outline of lower passage in relative position
connection between levels
Lower (left) Passage Profile (shifted down for clarity)
looking north
dug trail level
370
365
360
355
350m (ASL)

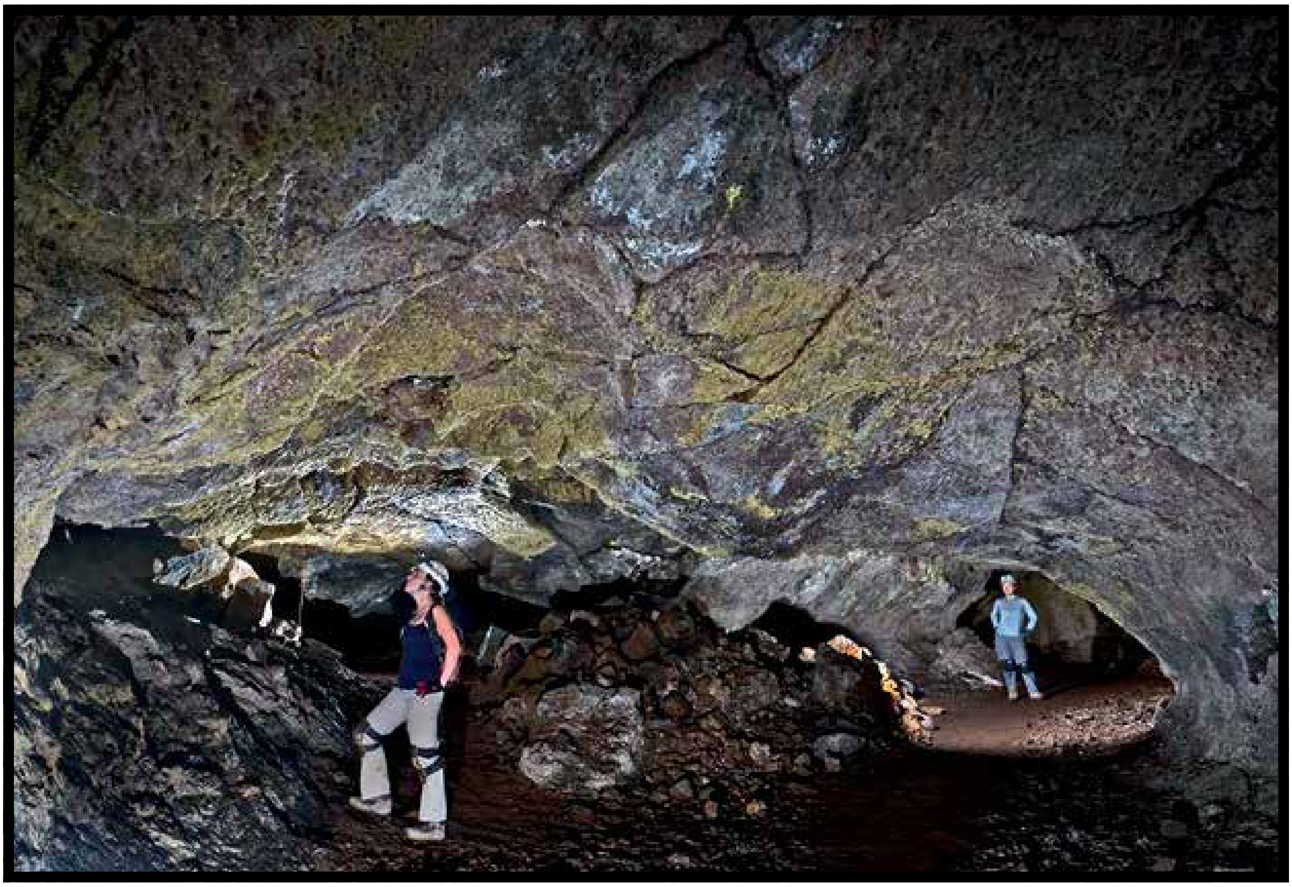


Dave Bunnell



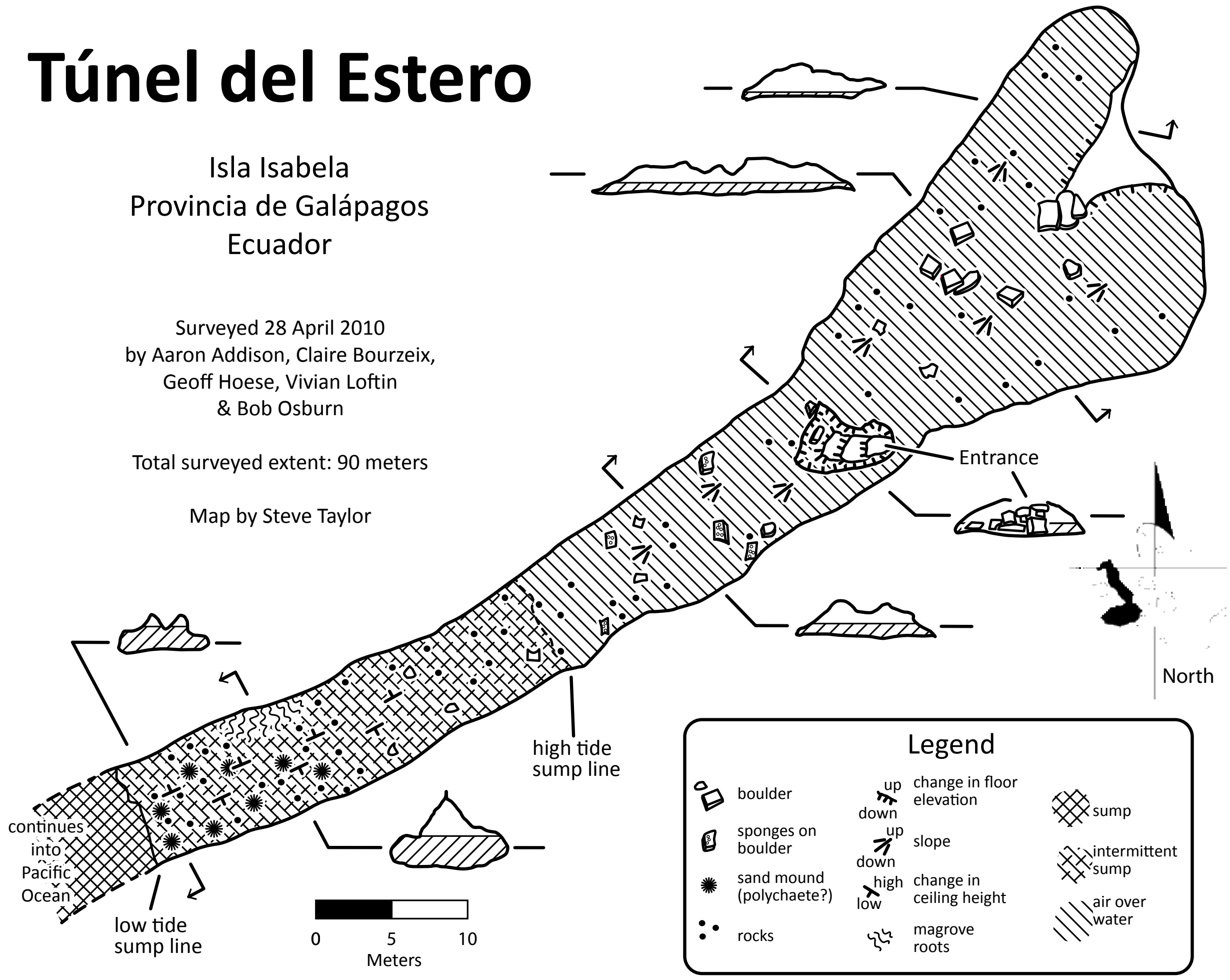
Dave Bunnell

SUCRE CAVE



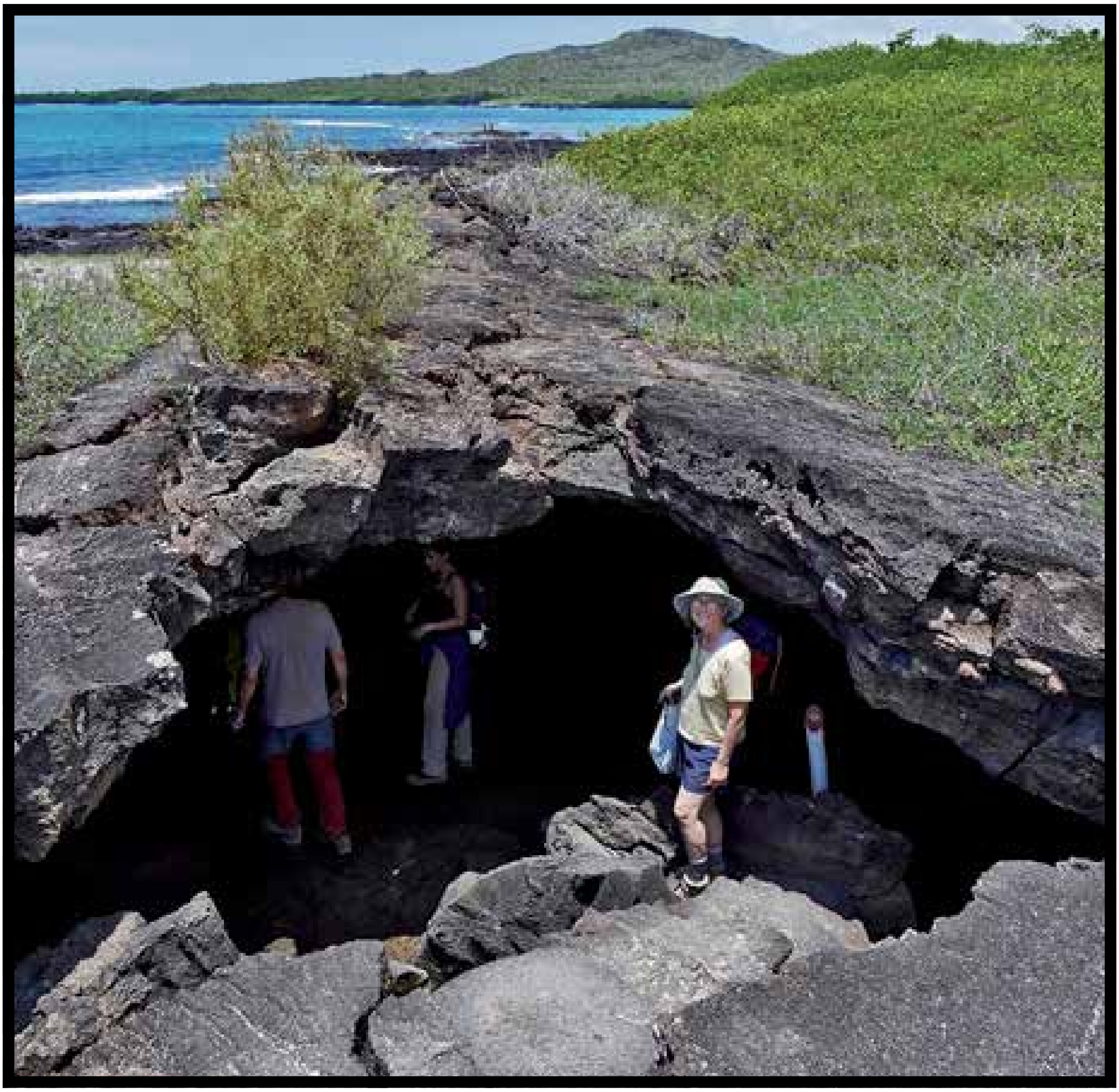
Dave Bunnell

Dave Bunnell



Guinevere McDaid *Dave Bunnell*

ESTERO CAVE



Dave Bunnell

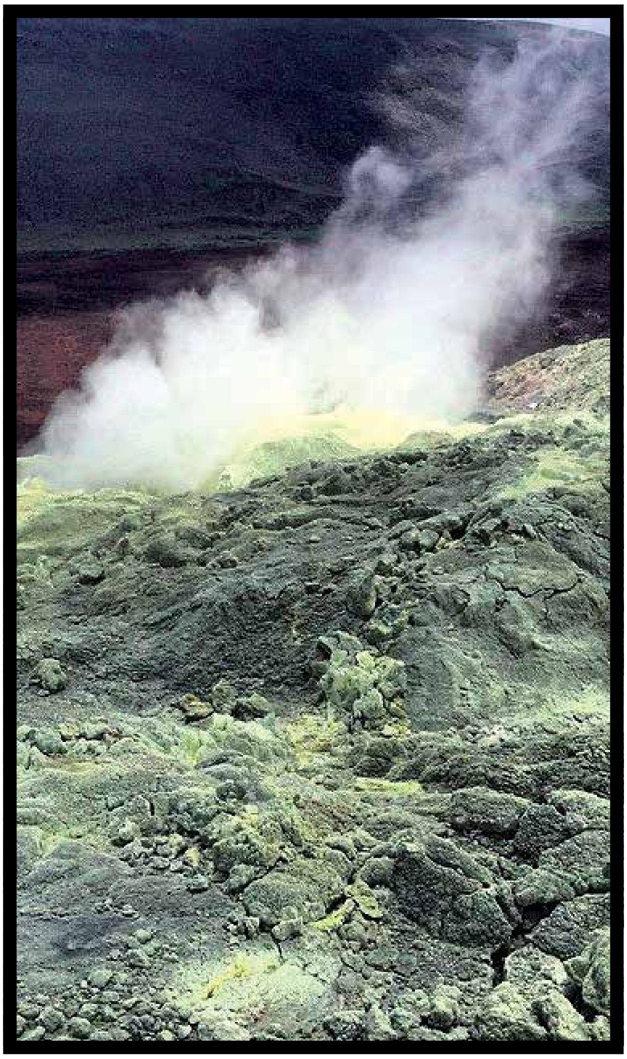
Early departure to Puerto Ayora, Island Santa Cruz / Baltra with boat leaving at 6.00 a.m.. Transfer to hotel or airport flight to Guayaquil / Quito and out.

Scientist enjoying farewell dinner *Maximillian Dornseif*

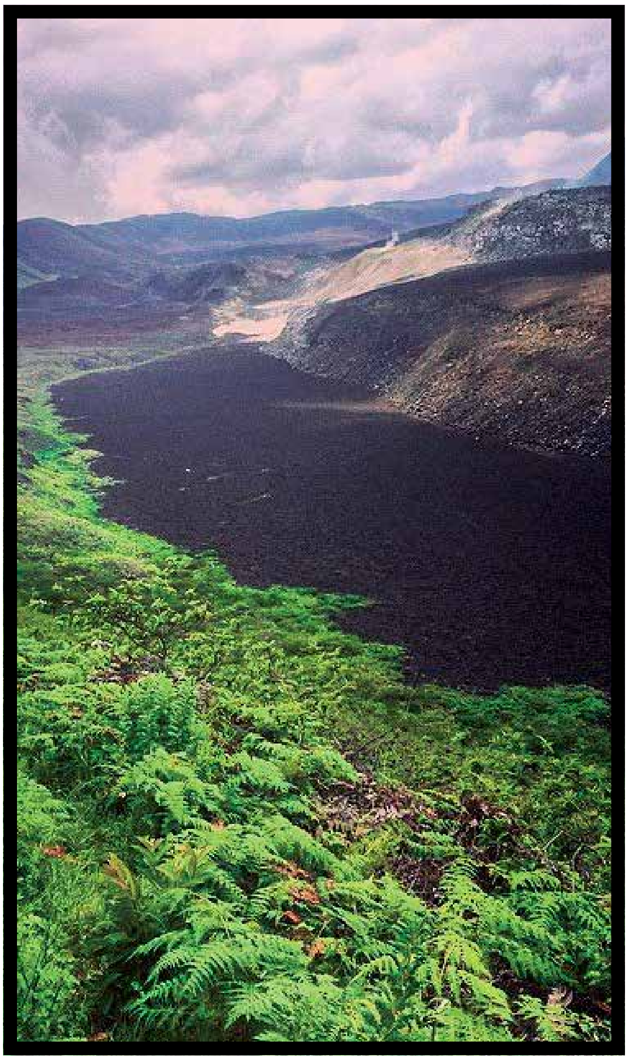
Transport by turist van to farewell dinner *Maximillian Dornseif*

Or stay at Isabela for fieldtrip to volcano Sierra Negra (Sulfur Mines) or other activities in order to return Sunday to Santa Cruz, scuba diving activities pending and organized by Jorge Mahauad Witt or flying home.

Sierra Negra Caldera taken from the east to the west



Sulfur fumaroles in Isabela volcano crater *Maximillian Dornseif*



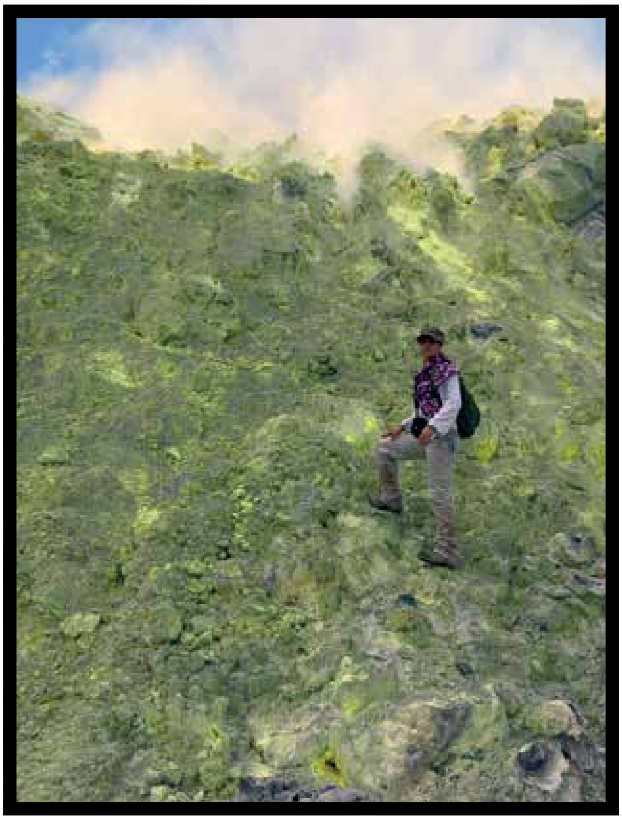
Lava river inside Isabela volcano crater *Maximillian Dornseif*

Theofilos Toulkeridis

Phill Collett

Phill Collett

Phill Collett



Visit the sulfur fumaroles in Isabela volcano cráter *Raquel Daza Brunet*

Paolo Forti *Phill Collett*

Maximillian Dornseif

Raquel Daza Brunet and José María Calaforra Chordi *Raquel Daza*

Visit the sulfur fumaroles in Isabela volcano cráter

Visit the sulfur fumaroles in Isabela volcano cráter *Phill Collett*

Phill Collett

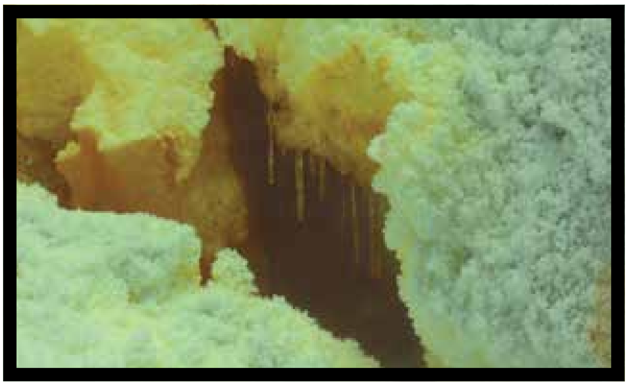
Phill Collett

Raquel Daza Brunet Phill Collett

Sulfur Pahoehoe Theofilos Toulkeridis

Raquel Daza Brunet

Phill Cillett

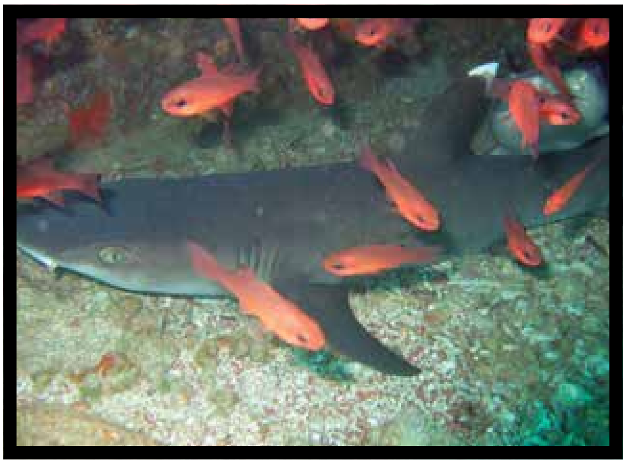


Sulfur composed stalactites Theofilos Toulkeridis

Sulfur composed stalactites *Theofilos Toulkeridis*

Henry Maninakis

Henry Maninakis



Henry Maninakis

Theofilos Toulkeridis

Henry Maninakis

Tuesday 25th of March

We start at 9.00 a.m from Quito traveling towards the Sub-Andean zone and Amazonian Lowland. Visits at Pasohurco, Province of Orellana Province in three smaller caves. Stay in Loreto.

Theofilos Toulkeridis at cruze rio Hollin on the way to Pasohurco *Franz Lindenmayer*

PASOHURCO

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Foto Raquel Daza Brunet 2nda fila derecha: Cementerio de elefantes en (Nombre de la zona). *Raquel Daza*

Franz Lindenmayer

Franz Lindenmayer

Raquel Daza Brunet

Raquel Daza Brunet

Franz Lindenmayer

Raquel Daza

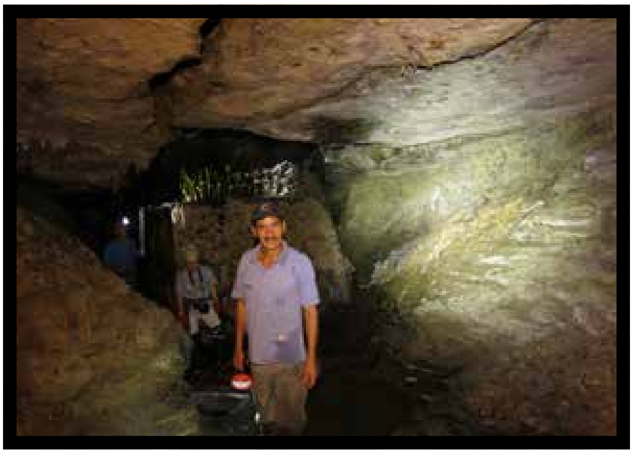
Raquel Daza

Raquel Daza

Theofilos Toulkeridis

Franz Lindenmayer

Raquel Daza



The late Daniel Carrasco with calcite stalactites to the left of the photograph
Raquel Daza

Franz Lindenmayer

Raquel Daza

Franz Lindenmayer

Franz Lindenmayer

Limestone (nombre cueva) cave in (nombre del lugar) *Raquel Daza*

Raquel Daza

Franz Lindenmayer

Entrance to the limestone (nombre cueva) cave in (nombre del lugar)
Raquel Daza

Pasohurco

Bats *Theofilos Toulkeridis*

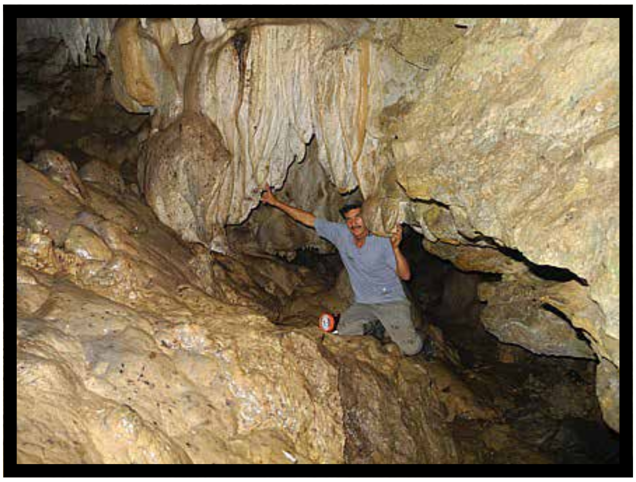
Calcite speleothems (stalagmites and columns) in Pasohurco limestone cave *Theofilos Toulkeridis*

Tarantula (spider) in Pasohurco cave *Theofilos Toulkeridis*

Harrestman *Raquel Daza*

Small vampire on the Pasohurco cave *Raquel Daza*

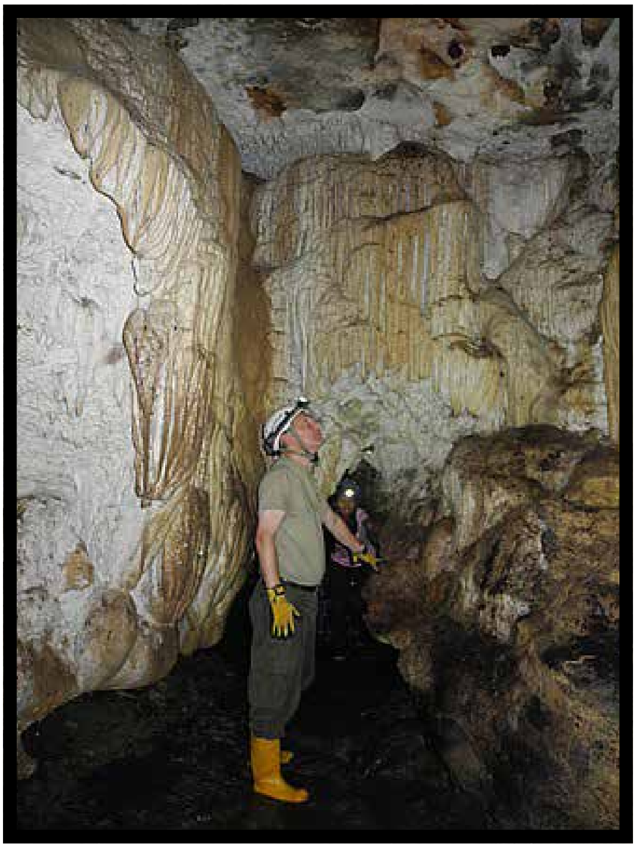
Franz Lindenmayer



Calcite stalactites and flowstones in Pasohurco cave

Raquel Daza

Franz Lindenmayer



Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Vampire *Raquel Daza*

Big calcite flowstones on the walls of the Pasohurco cave
Raquel Daza

Large accumulation of speleothems (flowstones and stalactites) in Pasohurco cave *Raquel Daza*

Cricked. It is the same kind that the calcified cricked *Raquel Daza*

First calcified cricket discobered by Raquel Daza Brunet in Pasohurco Cave *Raquel Daza*

Tarantula adult whith smal tarantula baby in Pasohurco cave
Raquel Daza

Speleologist observing calcite stalactites on the ceiling Pasohurco cave
Raquel Daza

Big flowstone covering the limestone hostrock of the Pasohurco cave
Raquel Daza

Speleologist inside the Pasohurco small tunel
Raquel Daza

Wednesday 26th of March

Visits of smaller carstic caves such as Ceremonia, Elefante in Cotundo, Jumandy in Archidona, Province of Napo. Stay in Tena.

CEREMONIA CAVE

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

CEREMONIA CAVE

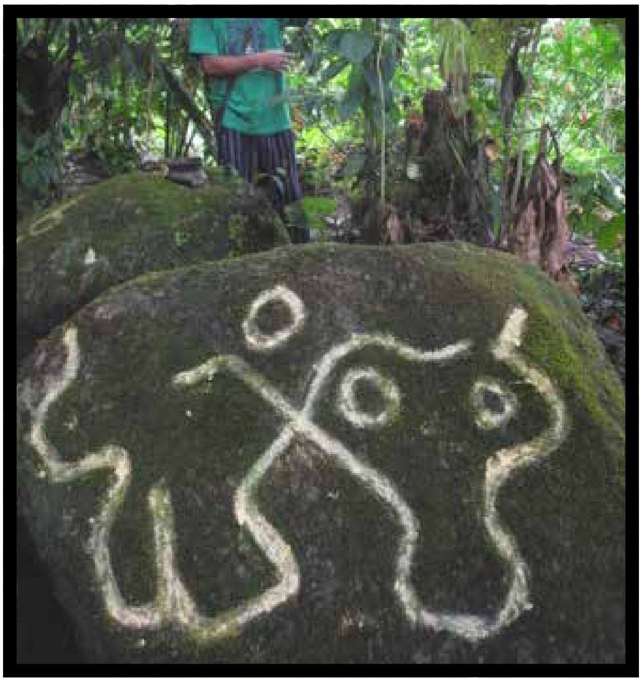
Franz Lindenmayer

Raquel Daza

Raquel Daza

Raquel Daza

Raquel Daza



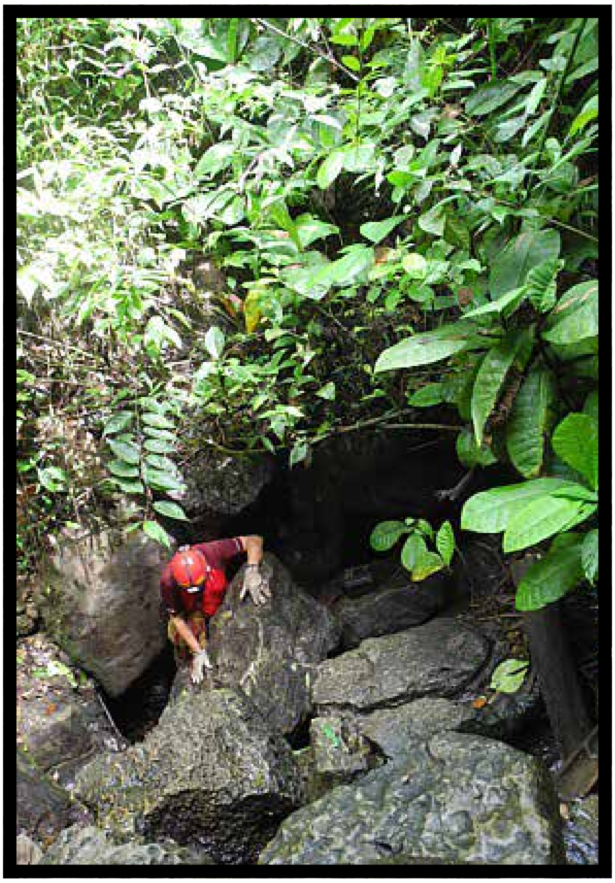
Franz Lindenmayer

CEREMONIA CAVE

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis



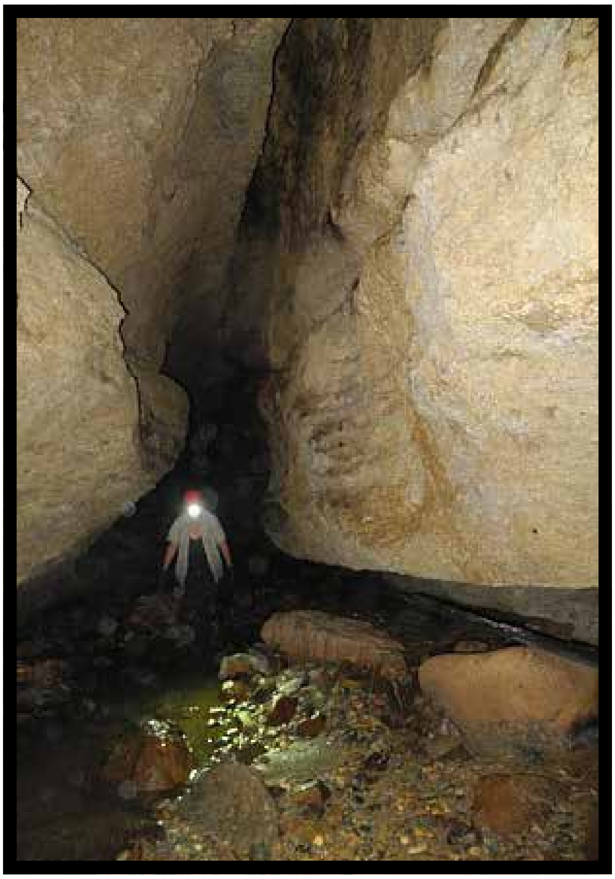
Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer



Franz Lindenmayer

Franz Lindenmayer

Theofilos Toulkeridis

Franz Lindenmayer

Franz Lindenmayer

Theofilos Toulkeridis

Franz Lindenmayer

Theofilos Toulkeridis

Franz Lindenmayer

Theofilos Toulkeridis

JUMANDY CAVE

Franz Lindenmayer

Raquel Daza

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Thursday 27th of March

Visit of caves Castillo and Gruta. Stay in Tena.

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Theofilos Toulkeridis

Raquel Daza

Franz Lindenmayer

Raquel Daza

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

Big calcite flowstones and columns in Castillo cave Raquel Daza

Speleologist exploring Raquel Daza

Bats Franz Lindenmayer

Bat flying Franz Lindenmayer

Boa constrictor Franz Lindenmayer

Pregnant Scorpion spider Raquel Daza

Big gallery that show a river curse Raquel Daza

Calcite stalactite Franz Lindenmayer

Theofilos Toulkeridis

GRUTA DE VIRGEN CAVE

Speleology exploration grup *Raquel Daza*

small tunel in Gruta de Virgen cave *Raquel Daza*

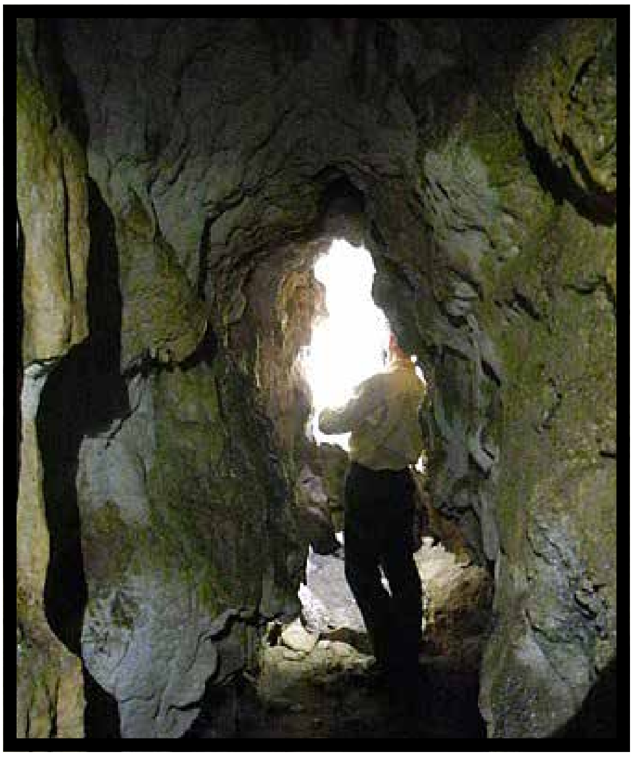
Poison frog *Raquel Daza*

Bat *Franz Lindenmayer*

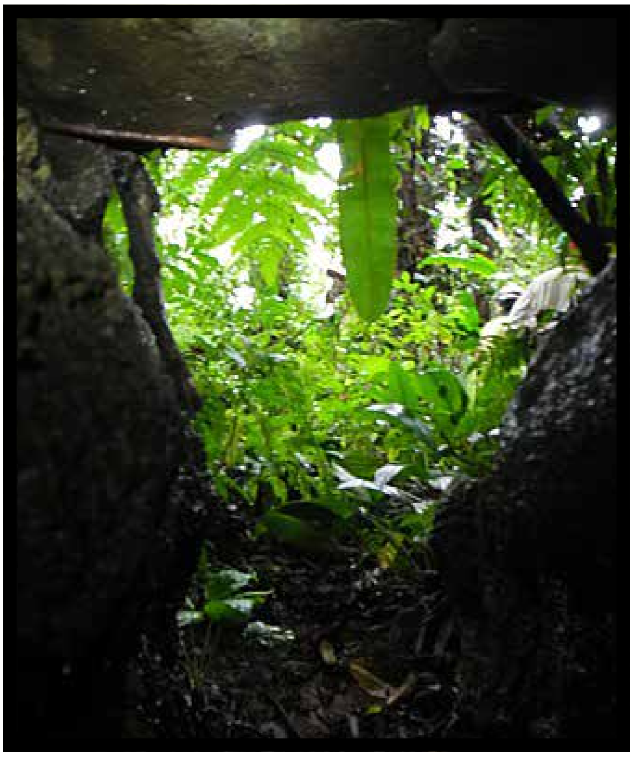
Raquel Daza

Franz Lindenmayer

scorpion spider baby (1cm) *Raquel Daza*



Franz Lindenmayer



Franz Lindenmayer

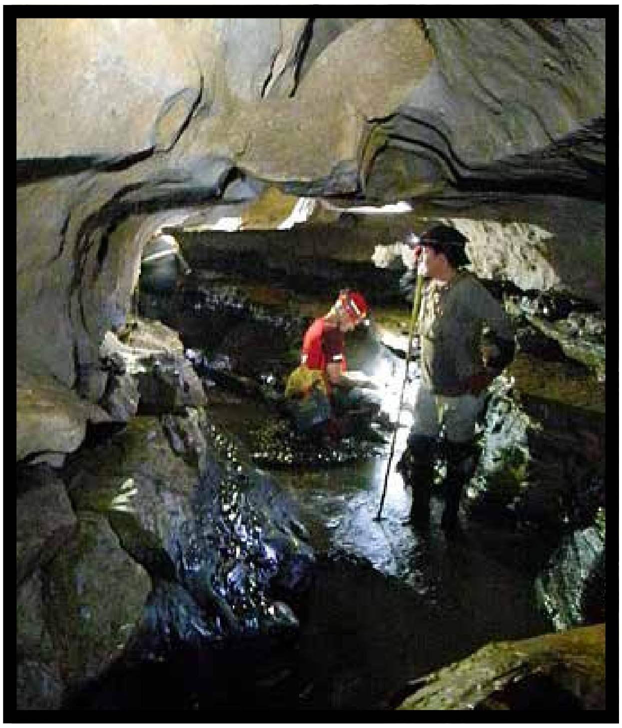
Friday 28th of March

Visit of Cave Uturcu Hurco. Transfer to and stay in Baños.

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer



Franz Lindenmayer

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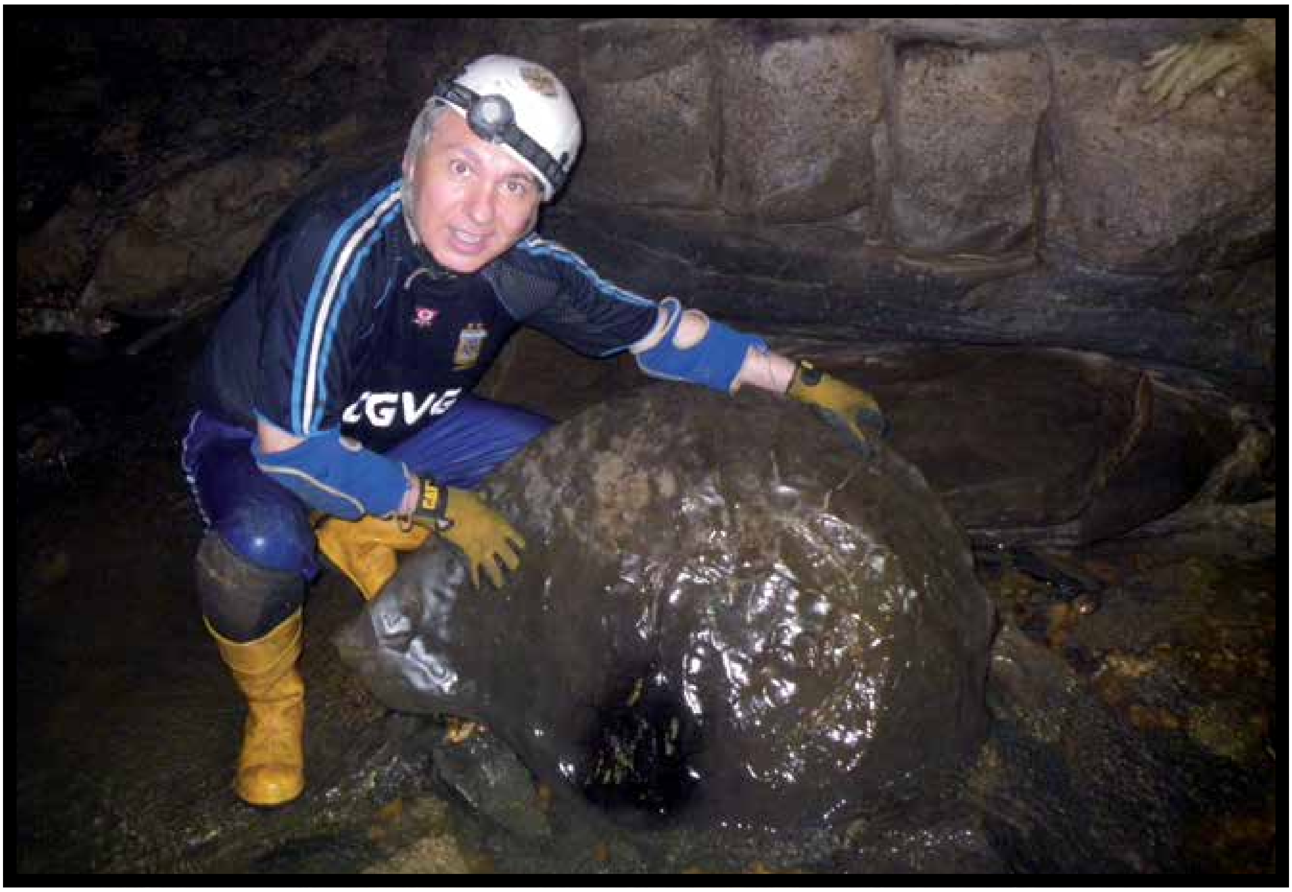
Franz Lindenmayer

UTURCU HURCO CAVE

Franz Lindenmayer

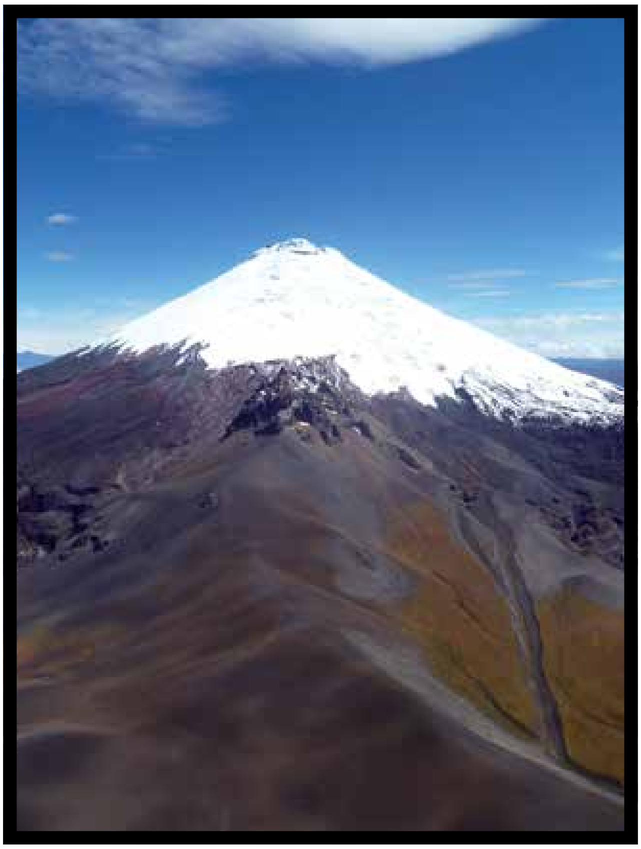
Franz Lindenmayer



Ecuador´s biggest amonite and its discover

Valrie Hildreth Werker

Sightseeing activities around Baños and Tungurahua volcano. Overnight in Quito.



Cotopaxi volcano — Theofilos Toulkeridis

Tungurahua volcano — Alois Speck

Chimborazo volcano — Alois Speck

Panecillo volcanic dome (Quito-Ecuador) — Theofilos Toulkeridis

Baños

Franz Lindenmayer

Franz Lindenmayer

Franz Lindenmayer

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Franz Lindenmayer

Franz Lindenmayer

14 | Galápagos — Galápagos, territorio para el Buen Vivir

GALÁPAGOS Y EL BUEN VIVIR

Consejo de Gobierno del Régimen Especial de Galápagos

ATRACTIVOS • El archipiélago presentó más motivos para visitarlo

Galápagos une al turismo y a la ciencia

La campaña turística 'All you need is Ecuador' y los descubrimientos científicos se sumaron a las múltiples maravillas encontradas por los turistas. Expertos realizarán nuevos estudios en las islas encantadas.

Decenas de turistas nacionales y extranjeros se acercaron a la letra gigante O colocada en el Malecón de Puerto Ayora, del 1 al 10 de abril, como parte de la campaña 'All you need is Ecuador' (Lo único que necesitas es Ecuador) que promocionó las riquezas del Ecuador para incrementar el número anual de turistas. Esta estrategia turística estuvo desplegada en 12 países a escala internacional y en 7 provincias del Ecuador.

"Todo lo que sea constructivo siempre será bueno y es una forma de difundir el turismo, de manera especial en el paraíso de las islas encantadas", manifestó la guayaquileña Leonela Llanos mientras se tomaba una foto junto a la letra de 6 metros de alto.

En la isla Santa Cruz se realiza la mayoría de las operaciones turísticas, razón suficiente para que se haya elegido el muelle del malecón de Puerto Ayora como el sitio para que los curiosos se enteren sobre la campaña.

El Coordinador de turismo de la zona insular Iván Carrignani manifestó que el Ministerio de Turismo adquirió los derechos de uso del tema original de Beatles 'All you need is love' para adaptarlos en las piezas comunicacionales.

Científicos analizaron la espeleología volcánica en las islas Galápagos

Científicos en espeleología volcánica examinaron la geología, vulcanología, entomología, plantas, raíces, aire, atmósfera, humedad, estabilidad de las cuevas, cavernas y túneles que existen en las islas Santa Cruz e Isabela de Galápagos.

Los expertos participaron durante 6 días en el décimo sexto Simposio Internacional de Espeleología, desarrollado del 16 al 22 de marzo de 2014.

Durante el evento se reveló que nuevos descubrimientos, realizados en 2007 por parte de la Escuela Superior Politécnica de Ejército en coordinación de universidades e institutos de Estados Unidos, provocaron que científicos de todo el mundo pongan su mirada en el universo subterráneo que existe en Galápagos. "Cada año regresamos aquí y es la base para poder atraer a la gente de todo el mundo para enseñarles lo que tenemos", acotó Theofilos Toulkeridis, expositor y responsable del simposio.

En la reunión también se conoció que Santa Cruz posee la caverna más larga de América del Sur (490 metros de largo) denominada La Llegada, y está entre el top 10 del mundo.

Otra novedad importante es el tesoro que alberga la Cueva de la Hormiga Roja ubicada en la isla Isabela, a la que se puede acceder solo gateando. "Hemos encontrado ratones gigantes (especie extinta), iguanas y 6 tortugas enteras de una especie que se extinguió antes de que llegara el ser humano a las islas", señaló Toulkeridis.

En un futuro cercano, los científicos esperan extender los estudios al sur y norte de Sierra Negra (Isabela), a las islas Floreana, Santiago y Fernandina. "También queremos encontrar con las partes submarinas", mencionó Toulkeridis.

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ecuador ama la vida — Ministerio de Turismo

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Ministerio de Turismo > Noticias > Científicos internacionales visitaron la provincia de Orellana

Noticias

Científicos internacionales visitaron la provincia de Orellana

Compartir | Twittear 2 | Imprimir | Enviar

Loreto (28-03-2014).- Un grupo de científicos dedicados a la espeleología volcánica y procedentes de Alemania, Inglaterra, EE.UU., España y Ecuador visitaron durante dos días el cantón Loreto en la provincia de Orellana para realizar sus actividades sobre esta especialidad científica que se desarrolla en cuevas volcánicas, aquellas que son creadas por la lava durante un proceso de erupción.

Durante este tiempo se analizó la geología y arqueología de la parroquia Huaticocha, además de la taxonomía y clasificación de murciélagos y vampiros, la estabilidad de las cuevas y cavernas que existen en la Zona de Pasohurco, específicamente.

Los estudios de clasificación cretácica de la zona son abundantes y se espera una próxima evaluación, para escanear capas tectónicas y conocer la antigüedad de la zona marina que cubrió en su momento las áreas de la Amazonía, afirmó Theofilos Toulkeridis, especialista Dr. Ph internacional de Espeleología.

A esta excelente noticia se suma el hallazgo de una especie de insecto grillo, un fosilizado tesoro que guarda la Caverna Milagro de Dios, ubicada en la zona de Pasohurco. "Al quedarse atrapados se convirtieron en un tesoro paleontológico, sólo esta caverna sería un museo paleontológico en el mundo", subrayó Theofilos Toulkeridis.

En un futuro cercano, los científicos esperan visitar conjuntamente con delegados en turismo, para que se fortalezca y se promocionen actividades de turismo científico e igualmente extender los estudios en las siguientes provincias Amazónicas.

(LTG)

Noticias Destacadas

- Convocatoria al Concurso de Méritos y Oposición
- Éxito total con el Campeonato Mundial del Hornado en Imbabura

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Expertos internacionales en espeleología volcánica se reúnen en Galápagos

Publicado el 15 marzo, 2014 por turismo

Santa Cruz (15-03-2014).- Del 16 al 24 de marzo, Galápagos es la sede del Décimo Sexto Simposio Internacional de Espeleología, que tiene por objetivo compartir los estudios realizados sobre las cuevas de lava y la tecnología que utilizan para buscar nuevas cuevas de lava alrededor del mundo.

Alrededor de 58 participantes de Australia, Estados Unidos, Alemania, Reino Unido, México, Islandia, Suiza, España, Japón, Italia, Hungría y Ecuador- serán parte del Décimo Sexto Simposio Internacional de Espeleología, -segundo realizado en el Ecuador – y el primero en Galápagos.

Estudiar el origen y la formación de las cavernas y las cavidades subterráneas naturales, así como la flora y fauna, es la pasión que tiene un grupo de científicos que visitarán las Islas Galápagos, para compartir sus conocimientos sobre las formaciones geológicas de diversos lugares de mundo, incluidas las islas Galápagos.

Entre las actividades que desarrollarán, durante los 6 días de visita, los expertos en espeleología volcánica, está la visita de campo a las cuevas de lava que fueron mapeadas con anterioridad y están a 400, 1,000 y 2,200 metros de altura del archipiélago. "Todas las cuevas que visitarán ya fueron mapeadas los años anteriores. Ahora estamos ubicando nuevas cuevas como las cascadas de lava que están por el Cascajo (parte alta de Santa Cruz) que son impresionantes, es de otro mundo", resaltó TheofilosToulkeridis, expositor y responsable del décimo sexto Simposio Internacional de Espeleología.

En la isla Isabela, un grupo de expertos, descenderán al Triple volcán, en vertical, para observar la singularidad de la cámara de magma que tiene por techo rocas de varios colores, que en conjunto forman un arco iris. "Para que hacemos esto, para que la gente no solo se vaya a los barcos, sino que el turismo doméstico -isleño- se quede vivo", indicó Toulkeridis, al puntualizar que se puede brindar una experiencia diferente a los turistas que llegan al archipiélago y que en ningún caso competiría con el turismo que ya se realiza en las islas Galápagos.

EQB/MYV

Publicado en Noticias | Deja una respuesta

Publicado: : 29 de marzo de 2014 Noticias

Científicos internacionales visitaron la provincia de Orellana

Un grupo de científicos dedicados a la espeleología volcánica y procedentes de Alemania, Inglaterra, EE.UU., España y Ecuador visitaron durante dos días el cantón Loreto en la provincia de Orellana para realizar sus actividades sobre esta especialidad científica que se desarrolla en cuevas volcánicas, aquellas que son creadas por la lava durante un proceso de erupción.

Durante este tiempo se analizó la geología y arqueología de la parroquia Huaticocha, además de la taxonomía y clasificación de murciélagos y vampiros, la estabilidad de las cuevas y cavernas que existen en la Zona de Pasohurco, específicamente.

Los estudios de clasificación cretácica de la zona son abundantes y se espera una próxima evaluación, para escanear capas tectónicas y conocer la antigüedad de la zona marina que cubrió en su momento las áreas de la Amazonía, afirmó Theofilos Toulkeridis, especialista Dr. Ph Internacional de Espeleología.

A esta excelente noticia se suma el hallazgo de una especie de insecto grillo, un fosilizado tesoro que guarda la Caverna Milagro de Dios, ubicada en la zona de Pasohurco. "Al quedarse atrapadas se convirtieron en un tesoro paleontológico, sólo esta caverna sería un museo paleontológico en el mundo", subrayó Theofilos Toulkeridis.

En un futuro cercano, los científicos esperan visitar conjuntamente con delegados en turismo, para que se fortalezca y se promocionen actividades de turismo científico; e igualmente extender los estudios en las siguientes provincias Amazónicas.

Ministerio de Turismo

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Noticias

Expertos en espeleología volcánica visitaron las Islas Galápagos

Compartir | Twittear 9 | Imprimir | Enviar

Santa Cruz (25-03-2014).- Un grupo de científicos de la élite mundial, en espeleología volcánica, permanecieron en las islas Galápagos durante los 6 días que duró el décimo sexto Simposio Internacional de Espeleología.

Durante este tiempo se analizó la geología y vulcanología, además de la entomológica -insectos-, la parte de plantas, raíces, aire, atmósfera, la humedad, la estabilidad de las cuevas, cavernas y túneles que existen en las islas Galápagos, específicamente en la islas Santa Cruz e Isabela.

Los estudios más antiguos sobre cavernas en Galápagos datan de 40 años atrás, sin embargo nuevos descubrimientos realizados en el 2007, por parte de la Escuela Superior Politécnica de Ejército en coordinación de universidades e institutos de Estados Unidos, llevaron a que científicos del planeta pongan su mirada en un mundo subterráneo que existe en Galápagos. *"Cada año regresamos aquí y es la base para poder atraer a la gente de todo el mundo para enseñarles lo hay en estas islas"*, acotó Theofilos Toulkeridis, expositor y responsable del décimo sexto Simposio Internacional de Espeleología.

En el desarrollo de este simposio se conoció que Santa Cruz posee la caverna más larga de América del Sur -490 metros de largo-, denominada "La Llegada", y está los tops 10 del mundo.

A esta excelente noticia se suma el tesoro que alberga la Cueva de la Hormiga Roja, ubicada en la isla Isabela (se puede acceder solo gateando). "Hemos encontrado ratones gigantes (especie extinguida), iguanas y 6 tortugas enteras de una especie que se extinguió antes de que llegara el ser humano a las islas", todas estas especies "al quedarse atrapadas se convirtieron en un tesoro paleontológico, sólo esta cueva sería un museo paleontológico en el mundo". Subrayó Theofilos Toulkeridis.

En un futuro cercano, los científicos esperan extender los estudios al sur y norte del volcán Sierra Negra (Isabela), a las islas Floreana, Santiago y Fernandina. "También queremos incursionar con las partes submarinas", menciona Toulkeridis, quien también está convencido que el turismo no tradicional es la mejor opción para que la población local alcance el Buen Vivir consagrado en la Constitución del Ecuador.

El simposio se realizó en Galápagos del 16 al 24 de marzo, con la participación de 58 científicos de Australia, Estados Unidos, Alemania, Reino Unido, México, Islandia, Suiza, España, Japón, Italia, Hungría y Ecuador.

EQ/MYV

Noticias Destacadas

- Convocatoria al Concurso de Méritos y Oposición
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PLANETA
VIERNES 04 DE ABRIL DE 2014
La Hora, ECUADOR
B9

Galápagos maravilla ahora con sus cuevas

Su belleza puede ser aprovechada para incrementar el área de turismo en las Islas.

El Archipiélago tiene una infinidad y variedad de cuevas que han traído y traerán más de una sorpresa, pues constituyen verdaderos tesoros paleontológicos naturales.

Por ejemplo, en la Isla Santa Cruz se encuentra la caverna más larga de América del Sur y en Isabela hay una cueva donde reposan restos fósiles de ratones gigantes, iguanas y tortugas de especies ya extinguidas.

"En la oscuridad y el silencio más profundos existe una forma fascinante de vida endémica bajo el maravilloso y encantador mundo de Galápagos, entonces la importancia de las cuevas volcánicas es más que evidente", manifestó Theofilos Toulkeridis, responsable del Décimo Sexto Simposio Internacional de Espeleología, que se realizó el mes anterior en la provincia insular.

Conociendo las riquezas subterráneas

Toulkeridis señaló que la incipiente investigación de los túneles de lava ha hecho presumir que esta área puede ser la más importante en cuanto a aspectos espeleológicos en cuevas volcánicas en el mundo.

Además de sus misterios geológicos, los interiores más profundos de las grietas subterráneas y de las cuevas se abren hacia un universo bajo tierra donde criaturas vivientes, casi todas ciegas, sin color y sin capacidad de volar se han adaptado a las cuevas de lava "formadas caprichosamente como tubos" y han descubierto muchas formas de encontrar comida y de movilizarse en el medio. En este sorprendente ecosistema la vida se desarrolla en constante evolución", aseguró el experto, quien agregó que algunos animales atrapados en tubos pueden preservarse y servir para la reconstrucción de la evolución animal pasada mucho después de su extinción.

Museos naturales

Con gran satisfacción, Theofilos Toulkeridis comentó que las cuevas se han constituido en verdaderos yacimientos paleontológicos y es que, debido a sus características físicas y climáticas, han preservado huesos que datan de hace miles de años.

Señaló que un registro fósil del Holoceno (la última y actual época geológica del período Cuaternario, los últimos 11.784 años, desde el fin de la última glaciación) demuestra que la mayoría de casos de extinción en Galápagos ocurrieron después de la llegada del hombre, como es el caso de especies de Megaoryzomis (roedores gigantes, hoy extintos) y que ahora son conocidas gracias a que sus huesos fueron hallados dentro de los tubos de lava (cavernas).

"La mayoría de fósiles de las Galápagos fueron encontrados en los tubos de lava debido a que antiguamente constituyeron posaderos de lechuzas, o por ser trampas naturales en las que quedaban atrapadas tortugas, por eso es que se han encontrado huesos", refirió el vulcanólogo.

Asimismo, los tubos de lava se han constituido en depósitos efectivos para la sedimentación terrestre; el interés en los fósiles de Galápagos de la era Cuaternaria son el resultado de colecciones realizadas en depósitos estratigráficos asociados a tubos de lava, donde se halló sobre todo fósiles de caracoles. Galápagos tiene mucho por mostrar. (CM)

Conozca
Estudios

- En el Décimo Sexto Simposio de Espeleología se analizó la geología, vulcanología y la entomología.
- También se analizaron las plantas, raíces, aire, atmósfera, la humedad.
- La estabilidad de las cuevas, cavernas y túneles que existen en las islas Santa Cruz e Isabela fueron parte de la investigación.
- Los estudios más antiguos sobre cavernas en Galápagos datan de 40 años atrás.
- Los nuevos descubrimientos realizados en 2007 por parte de la Escuela Superior Politécnica de Ejército, en coordinación de universidades e institutos de Estados Unidos, llevaron a que científicos del planeta pongan su mirada en el mundo subterráneo que existe en Galápagos.

Las maravillas fueron expuestas

Científicos de Australia, Estados Unidos, Alemania, Reino Unido, México, Islandia, Suiza, España, Japón, Italia, Hungría y Ecuador, reunidos en el Simposio de Espeleología, conocieron que la Isla Santa Cruz posee la caverna 'La Llegada', la más larga de América del Sur, con 490 metros de largo, y está en los tops 10 del mundo.

Mientras que en Isabela se encuentra la cueva de la 'Hormiga Roja', donde se encontraron ratones gigantes (especie extinguida), iguanas y seis tortugas enteras de una especie que se extinguió antes de que llegara el ser humano a las Islas. Para ingresar en la cueva se debe hacerlo gateando. Todas estas especies, "al quedarse atrapadas, se convirtieron en un tesoro paleontológico, sólo esta cueva sería un museo paleontológico en el mundo", subrayó Theofilos Toulkeridis.

Aquí también está el Triple volcán, lugar en el cual se puede descender en vertical para observar la cámara de magma que tiene por techo rocas de varios colores, que en conjunto forman un arco iris.

"Hacemos esto para que la gente no sólo se vaya a los barcos, sino que el turismo doméstico -isleño- se quede vivo", indicó Toulkeridis, al puntualizar que se puede brindar una experiencia diferente a los turistas que llegan al Archipiélago.

DIVERSIDAD. Hay tres tipos de cuevas o cavernas: las de accidentes morfológicos, las volcánicas y las kársticas. (Theofilos Toulkeridis)

PLANETA

SÁBADO 19 DE ABRIL DE 2014 La Hora, ECUADOR B9

FOSIL. Los espeleólogos encontraron el fósil, probablemente el más grande de Ecuador, de la era del Mesozoico. (Foto: Theofilos Toulkeridis)

Cavernas y tesoros en la Amazonía

Un grupo de científicos se desplazó hacia esta zona del país para explorar las cuevas y las especies.

El análisis de la geología y arqueología de la taxonomía y clasificación de murciélagos y vampiros, la estabilidad de las cuevas y cavernas en las provincias de Orellana y Napo, concentró a científicos dedicados a la espeleología volcánica de Alemania, Inglaterra, EE. UU., España y Ecuador, en la Décima Sexta Cumbre Mundial de Espeleología Volcánica, que se realizó del 16 al 24 de marzo.

El evento internacional se desarrolló principalmente en las Islas Galápagos, pero los expertos visitaron también varias cuevas de la Amazonía.

"Los estudios de clasificación cretácica de la zona son abundantes y se espera una próxima evaluación para escanear capas tectónicas y conocer la antigüedad de la zona marina que cubrió en su momento a las áreas de la Amazonía", afirmó Theofilos Toulkeridis, especialista, Dr. PhD Internacional de Espeleología.

Amazonía
Resultados principales

- Proponer la elaboración de una ruta de cuevas para fomentar el turismo local, el culto, la conservación del ambiente y deporte extremo.
- Elaborar un inventario de flora y fauna con las especies endémicas encontradas.
- Evaluar la configuración de las cuevas para clasificar su origen tectónico y geomorfológico.
- Estudio y clasificación geológica y paleontológica de los fósiles encontrados.
- Inventario entomológico y búsqueda de nuevas especies (se encontraron varias).

VIDA. Varias especies de animales se han adaptado a vivir en la oscuridad y humedad de las cuevas. (Foto: Theofilos Toulkeridis)

Hallazgos excepcionales

En este mundo subterráneo se hicieron sorprendentes descubrimientos de su paisaje, su contenido biológico y hasta bacteriológico. "No sería ninguna sorpresa encontrar en nuestras investigaciones múltiples nuevas especies entomológicas, de bacterias y hasta de mamíferos al lado de restos paleontológicos", indicó Toulkeridis.

Se halló por ejemplo un ejemplar de insecto grillo, un fosilizado tesoro que guarda la Caverna Pasohurco (Milagro de Dios). "Al quedarse atrapadas se convirtieron en un tesoro paleontológico, solo esta caverna (Pasohurco) sería un museo paleontológico en el mundo", subrayó.

Especificaciones de las cuevas

Toulkeridis indica que en la región Amazónica existe un millar de cuevas kársticas formadas por el agua de lluvia sobre terrenos calizos.

La roca caliza es abundante en muchos macizos montañosos y está formada por carbonato de calcio ($CaCO_3$), que no es soluble en agua. Sin embargo, "basta con que el agua de lluvia tenga en disolución cierta cantidad de anhídrido carbónico (CO_2) para que el carbonato de calcio se transforme en bicarbonato y por tanto el resultado: una cueva kárstica", explicó.

En el caso de la cuenca amazónica "encontramos grandes karst en la formación Napo, del periodo Cretácico. Abundantes ejemplos existen en la región alrededor de Baeza, Archidona, Tena, Puyo, Macas y la cueva más famosa llamada Los Tayos en Morona Santiago, entre otras", aseguró. (CM)

WEB
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ESPACIOS. En la Amazonía existen cuevas grandes y pequeñas con diversas formas en su interior. (Foto: Theofilos Toulkeridis)

Tip ecológico

El consumo de energía desgasta los recursos naturales, por lo que es importante su ahorro.

End of post-symposium fieldtrip.

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NOTICIAS

Expertos en espeleología volcánica visitaron las islas Galápagos

marzo 26 2014

San Cristóbal (Galápagos).- Un grupo de científicos de la élite mundial en espeleología volcánica permanecieron en las islas Galápagos, durante seis los días que duró el décimo sexto Simposio Internacional de Espeleología.

Durante este tiempo se analizó la geología y vulcanología, además de la entomológica -insectos-, la parte de plantas, raíces, aire, atmósfera, el humedad, la estabilidad de las cuevas, cavernas y túneles que existen en las islas Galápagos, específicamente en la islas Santa Cruz e Isabela.

Los estudios más antiguos sobre cavernas en Galápagos datan de 40 años atrás. Sin embargo, nuevos descubrimientos realizados en el 2007, por parte de la Escuela Superior Politécnica de Ejército en coordinación de universidades e institutos de Estados Unidos, llevaron a que científicos del planeta pongan su mirada en un mundo subterráneo que existe en Galápagos.

"Cada año regresamos aquí. Y es la base para poder atraer a la gente de todo el mundo para enseñarles lo que hay en estas islas", acotó Theofilos Toulkeridis, expositor y responsable del décimo sexto Simposio Internacional de Espeleología.

En el desarrollo de este simposio se conoció que Santa Cruz posee la caverna más larga de América del Sur 450 metros de largo, denominada "La Llegada", y está los tops 10 del mundo.

A esta excelente noticia se suma el tesoro que alberga la Cueva de la Hormiga Roja, ubicada en la isla Isabela (se puede acceder solo gateando).

"Hemos encontrado ratones gigantes (especie extinguida), iguanas y 5 tortugas enteras de una especie que se extinguió antes de que llegara el ser humano a las islas", todas estas especies "al quedarse atrapadas se convirtieron en un tesoro paleontológico, [illegible] un museo paleontológico en el mundo", subrayó Theofilos Toulkeridis.

En un futuro cercano, los científicos esperan extender los estudios al sur y norte del volcán Sierra Negra (Isabela) a las islas Floreana, Santiago y Fernandina. "También queremos incursionar con las partes submarinas", mencionó Toulkeridis, quien también está convencido que el turismo no tradicional es la mejor opción para que la población local alcance el Buen Vivir consagrado en la Constitución del Ecuador. (Ministerio de Turismo)

20:32 En diciembre será la audiencia sobre caso Chevron-Texaco en Ecuador

NOTICIAS

Expertos internacionales en espeleología se reúnen en Galápagos

marzo 18 2014

Galápagos es la sede del Décimo Sexto Simposio Internacional de Espeleología (ciencia en que se exploran y estudian la formación, el origen y la naturaleza de las cavidades naturales subterráneas del suelo terrestre, y su fauna y flora). Que se realiza desde el 18 al 24 de marzo.

Alrededor de 50 participantes de Australia, Estados Unidos, Alemania, Reino Unido, México, Islandia, Suiza, España, Japón, Italia, Hungría y Ecuador participarán en el evento.

Entre las actividades que desarrollarán, los expertos en espeleología volcánica, está la visita de campo a las cuevas de lava que fueron mapeadas con anterioridad y están a 400, 1.000 y 2.200 metros de altura del archipiélago.

"Ahora estamos ubicando nuevas cuevas como las cascadas de lava que están por el Cascajo (parte alta de Santa Cruz) que son impresionantes, es de otro mundo", resaltó TheofilosToulkeridis, expositor y responsable del evento.

En la isla Isabela, un grupo de expertos, descenderán el Triple volcán, en vertical, para observar la singularidad de la cámara de magma que tiene por techo rocas de varios colores, que en conjunto forman un arco iris.

Toulkeridis, puntualizó que este sitio puede constituirse en un nuevo atractivo turístico. "Se puede brindar una experiencia diferente"

20:32 En diciembre será la audiencia sobre caso Chevron-Texaco en Ecuador

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NOTICIAS POLÍTICA ECONOMÍA DEPORTES MULTIMEDIA PROVINCIAS » MUNDO

Encuentran grillo fosilizado y cristalizado en cueva amazónica

23 abril, 2014 | Noticias, Orellana, Provincias | No comments

El hallazgo de un grillo que murió por hongos se fosilizó y cristalizó hasta la última parte de su cuerpo, y la existencia de varias especies de insectos, como arañas, nunca antes conocidos, hacen de las cuevas de Pasohurco (provincia de Orellana) un verdadero museo paleontológico, único en el mundo, dice con mucha emoción Theofilos Toulkeridis, especialista Dr. Ph Internacional de Espeleología.

"La forma en que se encontró al grillo y la vida en las cuevas se debe a las condiciones meteorológicas que existen en las mismas", manifestó el especialista, quien junto a científicos dedicados a la espeleología volcánica de Alemania, Inglaterra, EE. UU., España y Ecuador realizaron un recorrido por varias cuevas y cavernas de la Amazonía.

Especies no vistas

Toulkeridis señala que los insectos encontrados son de especies aún desconocidas a nivel mundial, por lo que las muestras recogidas serán enviadas a Estados Unidos para realizar estudios de taxonomía y de ADN.

"En este mundo conjugan perfectamente el flujo del agua de los ríos subterráneos con la geodinámica y litología (estudio de rocas) y los animales que allí habitan para formar un verdadero nicho ecológico que hace que las especies dependan unas de otras.

Es decir que "si se elimina una especie, se creará una problemática al equilibrio de la fauna de una cueva", comentaron los biólogos presentes.

Signos prehistóricos

Mientras en la cueva Uturcu Hurcu, se notó una fuerte evidencia de megafauna mesozoica (era de los dinosaurios) como son los restos de ammonite, una subclase de moluscos cefalópodos extintos que habitaron los mares desde el Devónico hasta finales del Cretácico.

Además de una preservación perfecta, el ammonite encontrado mide cuatro veces más que los conocidos en otros sitios del país. Solo en Orellana y Loja se hallaron fósiles de entre 20 y 25 centímetros, unos en buen estado y otros no, indicó Toulkeridis.

"Tras este descubrimiento, lo que resta es encontrar evidencias, en los mismos niveles, de huesos fósiles de Ichtyosaurus, Dakosaurus, dinosaurios marinos en la cuenca amazónica", culminó el experto. (CM)

Pistas

De los hallazgos

* El Ichthyosaurus vivió entre finales del Triásico a principios del período Jurásico.

* Por convergencia evolutiva tiene mucha semejanza con los delfines.

* Los Ichthyosaurus eran reptiles.

* Dakosaurus significa 'lagarto mordedor'.

Fuente: lahora.com.ec

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Expertos internacionales en espeleología volcánica se reúnen en Galápagos

El 17 marzo, 2014 | 0 Comentarios Nacionales

Galápagos es la sede del Décimo Sexto Simposio Internacional de Espeleología, que tiene por objetivo compartir los estudios realizados sobre las cuevas de lava y la tecnología que utilizan para buscar nuevas cuevas de lava alrededor del mundo.

Alrededor de 58 participantes de Australia, Estados Unidos, Alemania, Reino Unido, México, Islandia, Suiza, España, Japón, Italia, Hungria y Ecuador- serán parte del Décimo Sexto Simposio Internacional de Espeleología, -segundo realizado en el Ecuador – y el primero en Galápagos.

Estudiar el origen y la formación de las cavernas y las cavidades subterráneas naturales, así como la flora y fauna, es la pasión que tiene un grupo de científicos que visitarán las Islas Galápagos, para compartir sus conocimientos sobre las formaciones geológicas de diversos lugares de mundo, incluidas las islas Galápagos.

Entre las actividades que desarrollarán, durante los 6 días de visita, los expertos en espeleología volcánica, está la visita de campo a las cuevas de lava que fueron mapeadas con anterioridad y están a 400, 1,000 y 2,200 metros de altura del archipiélago. "Todas las cuevas que visitarán ya fueron mapeadas los años anteriores. Ahora estamos ubicando nuevas cuevas como las cascadas de lava que están por el Cascajo (parte alta de Santa Cruz) que son impresionantes, es de otro mundo", resaltó Theofilos Toulkeridis, expositor y responsable del décimo sexto Simposio Internacional de Espeleología.

En la isla Isabela, un grupo de expertos, descenderán al Triple volcán, en vertical, para observar la singularidad de la cámara de magma que tiene por techo rocas de varios colores, que en conjunto forman un arco iris. "Para que hacemos esto, para que la gente no solo se vaya a los barcos, sino que el turismo doméstico -isleño- se quede vivo", indicó Toulkeridis, al puntualizar que se puede brindar una experiencia diferente a los turistas que llegan al archipiélago y que en ningún caso competiría con el turismo que ya se realiza en las islas Galápagos.

17th International Symposium of Volcanospeleology in Hawaii, USA

2016


Ann and Annie Guiraud crossing collapsed lava lake
Ann and Peter Bos

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