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Union Internationale de Spéléologie (UIS)

Commission on Volcanic Caves

e-NEWSLETTER

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UIS Commission on Volcanic Caves

No. 86 - April 2026

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The Commission on Volcanic Caves Newsletter has been published regularly since December 22, 1993. The Newsletter is available free of charge to all members of the commission, and to others who are interested in Volcanic caves.

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UIS Commission on Volcanic Caves

UIS COMMISSION ON VOLCANIC CAVES

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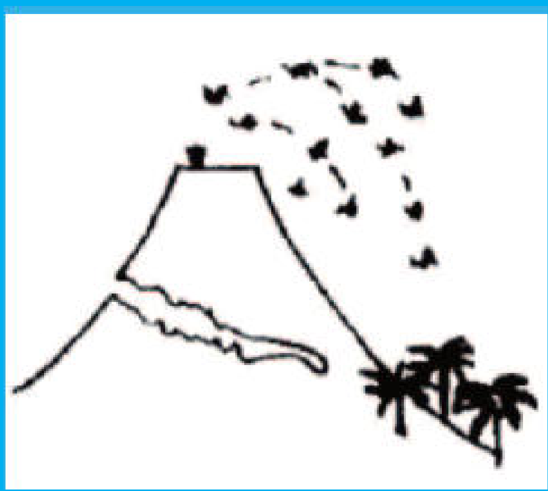
MISSION STATEMENT

The UIS Commission on Volcanic caves encourages exploration and scientific investigation on volcanic caves, and hosts the International Symposium on Vulcanospeleology about every two years



COVER PHOTOS:

Top:
Basalt columns in Armenia
Drone photo: M. Lenoir

Bottom:
An unclear geological feature above a cave entrance in Herher, Armenia.
Photo: L. Smets

BACK COVER PHOTO:

Cheryl Gansecki and Richard Hazlett at Uekahuna Bluff at the northwest rim of Kaluapele, Hawaii.

Editorial

At the right: Jean Paul van der Pas
At the left: Laurens Smets

The first page of Newsletter 1 1993

Jan Paul van der Pas joined the commission around 1994 and is still a member today. For many years he served as editor and chairman, and he was the person who inspired me to start exploring volcano speleology. As a fellow member of Speleo Limburg and Speleo Nederland, he played an important role in sparking my interest in volcanic caves.

My previous life as a "limestone caver" for more than 40 years certainly served its purpose and proved very useful when exploring and discovering new passages in existing volcanic caves.

Back in 1993, producing the newsletter was quite a challenge. It was created on a manual typewriter, with text cut and pasted with glue to form the layout, and then distributed by post. Around 2005 the transition toward more digital formatting and distribution began, bringing its own new challenges. At one point this even resulted in a one-year gap without an editor between 2015 and 2017.

As the newsletter gradually became more professional in style and layout, keeping up with changing software became a real issue. Carlos Benetton did an excellent job producing the newsletter for several years, constantly adapting to modern developments and the never-ending stream of new software.
Now it is my turn, as Carlos' successor, to give it a try.

In today's digital world we receive megabytes and megabytes of information—single photos of 150 MB, files in PDF, PNG, TIFF, JPEG, SVG, RAW and many other formats. All of these are sent to the editor, who is then expected to reduce gigabytes of material to a reasonable publication size of around 10 MB. That said, upon request I can provide certain articles at any time in the highest resolution.

The second challenge is to stay true to our roots. This is a newsletter, not a professional magazine. So yes, it is not proofread by professional editors, and yes, mistakes may occur.
My aim is therefore simple: to provide useful information at a recreational to semi-scientific level, with acceptable quality and a clear, readable layout.

With this promise, I hope to lower the threshold a little and encourage a wider range of contributions - articles that reflect the activities and interests of all our members.

Your editor: Laurens Smets

Clarification newsletter (Number 85, dated September 2025)
Volcanic Caving in Saudi Arabia

In the last issue of this newsletter (Number 85, dated September 2025), we wrote an article reporting on a preliminary trip to Saudi Arabia in February 2025 to investigate "cave question marks" previously documented by John Pint. John is one of our true members, he is an American citizen who lived and worked in Saudi Arabia for a number of years and did a considerable amount of work to explore and document volcanic caves while he was there.

Following publication of the report, we understand the Commission received a message expressing concern about the apparent handling of objects observed during the group's investigations.

Although our report contained a statement advising that no artefacts were removed from the caves and our observations were based solely on observations and photographs, we wish to provide additional detail to clarify that where items were photographed or temporarily repositioned, this was done exclusively in disturbed areas, not in *original-deposition* contexts. These locations already showed clear signs of disturbance, including with shotgun shells, trash, and other recent anthropogenic modifications that predated our visit. Bones were handled or repositioned briefly for photographic purposes and then carefully returned to where they were found.

L. Smets, B. Langford, D. Frölich.

President's Column

A lot has been happening within the commission since the September 2025 issue of the newsletter. We have a new newsletter editor; membership is continuing to grow and now exceeds 170; parts of the website have been refreshed, especially the pages on the International Symposia on Vulcanospeleology (ISVs); and, I am pleased to say, planning for the next ISV (ISV22) is progressing nicely. And, I have even managed to visit a few volcanic caves …..

I welcome Laurens Smets as the new editor of the commission's newsletter. Laurens took over towards the end of last year. The handover was announced in an email to members in October 2025, but I wish to repeat some of that message to record in a more formal manner, my appreciation for the commitment Carlos Benedetto made to the commission over the past several years. He offered to take on the challenging role of compiling and producing the newsletter in English, a language that is not his own. He took over in January 2023, after the previous editor resigned. As editor, Carlos compiled and published six solid and informative issues. The first of these was produced just a few weeks after he started and that issue was compiled with significant assistance from Laurens as Carlos eased into the position.

Of key importance to many members, planning for the next International Symposium on Vulcanospeleology (ISV22) in the Canary Islands is now moving forward quickly after a slow and arguably uncertain start. The local organisers have encountered significant barriers to confirming some elements of their desired program on each island, but I am confident that everything will come together and that it will be a remarkable ISV with more participants than we have seen since before Covid times.

IMPORTANT NOTE: Since the following column was prepared in late February, the organiser of the La Palma post-symposium field excursion (Octavio Fernandez) has withdrawn from the ISV22 **organising team and has cancelled the La Palma excursion.** This is regretable and unfortunate. The ISV22 activities on Tenerife and Lanzarote are not affected by this decision.

I wish to thank everyone who completed a questionnaire expressing their interest in attending, or possibly attending, the ISV in November. Your responses have been very helpful to the organisers. If the expressions of interest translate into registrations, there will more than 60 participants for the core activities on Tenerife and a little over half that number for the optional pre-symposium trip to Lanzarote . The indicative numbers are very pleasing to the key organisers (Pedro, Esther and Laurens).

More information on ISV22 appears in this newsletter.

Webmaster Dirk Stoffels has revamped and updated the range of ISV documents available for download from the commission's website. The listings now cover all 21 ISVs that have been held since 1972. I take this opportunity to acknowledge the efforts of Professor Paulo Forti in tracking down a rare copy of the Proceedings of the 2nd ISV (held in Catania in August 1975). I also thank Professor Kyung-Sik Woo for providing an updated pdf copy of the Abstracts book for the 13th ISV (convened on Jeju Island, Korea in September 2008).

Sitting here in southeastern Australia, it is not easy to head into a volcanic cave, as the closest pyroducts are nearly 1000km away. However, Marjorie and I have made two visits to the Mt Porndon area in Western Victoria over the past 6 months. Spread across several privately-owned rural properties, it is a relatively small area that has attracted little interest from either vulcanologists or speleos over the years. However, that is now changing thanks to detailed research by, and the determination of, David Salter, who joined the commission last year. You can read more about the area in this issue.

John Brush
President, UIS Commission on Volcanic Caves

Information Circular 2

March 2026

22nd International Symposium on Vulcanospeleology

Canary Islands, November 2026

Introduction

The 22nd International Symposium on Vulcanospeleology (ISV22) will be held in the Canary Islands in November 2026. The core symposium program (presentation sessions, welcome reception, symposium dinner and two days of excursions) will take place on the island of Tenerife. These activities will be preceded by an optional field trip on Lanzarote island.

A program outline appears on pages 9-11 of these notes.

The symposium and field trips are being organised by a small team of cavers, clubs and scientists with generous logistical, organisational and financial support from the museums organisation of the Cabildo (ie, local government organisation) of Tenerife and the Cabildo of Lanzarote.

To ease the burden on organisers, participants will need to make all their own reservations for accommodation, flights to and from and, where applicable, between the islands, as well some land transport arrangements and most meals.
The fees for Tenerife will include a coffee break and a lunch (or picnic) for the four days, the closing dinner, and transportation for the two days of excursions.

Please read these notes carefully as some details have been revised since the preliminary notes were circulated in December 2025.

Cueva del Viento Tenerife. Image courtesy of Museos de Tenerife / Cabildo de Tenerife.

***Updated**

Welcome Reception

A welcome reception, hosted by the Museums organisation of Tenerife (Organismo Autónomo de Museos y Centros - OAMC), will be held on Wednesday evening, 4 November, at the Museo de Historia y Antropología de Tenerife (MHA) – the Museum of History - in central La Laguna. This is a more convenient location than the Museum of Nature in Santa Cruz, which had been suggested as the venue in the preliminary information notes circulated in December 2025.

Presentation sessions

Presentations will be held in La Laguna, Tenerife at the Museo de La Ciencia y El Comos (MCC) - the Museum of Science and the Cosmos- (Avda. Los Menceyes 70/n 38205 San Cristóbal de La Laguna. MCC is 1-2 km (walking distance) from the suggested hotels (see Accommodation, below) , but this distance can be reduced by taking a tram (see La Laguna Map on Page 5).

The amount of time allowed for each presentation will be announced later.

Field excursions

Field excursions will be organised on two islands, The cost of participating on the two single day trips on Tenerife is included in the symposium registration fee. The Tenerife trips will involve some easy-to-medium-difficulty walking both on the surface and in caves. There will be several cave trip options with varying degrees of difficulty. We can also offer for 8 to 10 people an alternative excursion to a volcanic pit (30 m deep) guided by an experienced caver, who will provide ropes and personal vertical caving equipment. It is recommended to bring a helmet and light, although we can provide for those who do not bring them, but not a suit or knee pads. The excursion to the caves of Teide National Park can be done with or without a helmet.

The field excursions to Lanzarote are optional and will be at additional cost. For some of the cave trips you will need to be fit and experienced and some caves on Lanzarote will require SRT gear. But there will also be easier options that will be suitable for most participants who are capable of walking and doing some easy caving. On Lanzarote, there will also be easier trip options focusing on surface volcanic features and caves needing no more equipment than a helmet and light. Please see the draft program outline at the end of these notes. More detailed advice on trips will be provided by the time registration opens.

Preliminary registration information

Registration for the ISV is expected to open early May, if not sooner, and will close at the end of August.

There will be a separate registration fee for each island. The following details are not firm, as some elements are still being negotiated . However, the following price indications will help intending participants estimate their total costs (which would need to include travel to/ from the Canary Islands; inter-island travel; all accommodation; and all meals, except as noted below).

Estimated fees for each island are provided below. Fees will be fixed by the time registration opens and may be higher, or lower, than these estimates.

Concessions. For activities on Tenerife, a concessional registration rate will be available for children under 18 years of age, as well as for bonafide full time tertiary students. For the pre-symposium Lanzarote trip, discounts on entrance fees will be available for participants under the age of 18 years.

Cancellation. If you need to cancel after you have registered for the core program on Tenerife, it will be possible to do so and we will be aiming to refund of most, if not all, of the money you had paid. Exact details are being negotiated, and further advice will be provided when registration opens. For the pre-symposium trip to Lanzarote, fees will not be refundable.

Fees:

Lanzarote. €140 (estimated), but will be less if institutional support is obtained.

Note: The Lanzarote field trip has been substantially revised from the outline provided in the preliminary information notes (circulated to commission members in December 2025).

The registration fee will cover transport by bus and minibus. No meals or entry fees are included

Tenerife. €275 per person (estimated).

This will cover the welcome event; attendance at the presentation sessions (including tea and coffee, use of conference room facilities with associated technical support and two lunches); symposium dinner; transport, access and lunches for field excursions to Teide National Park, and to caves in the Icod de los Vinos area, including Cueva del Viento (Cave of the Wind).

Accommodation

As noted above, you will need to make all your own accommodation arrangements on each of the islands that you visit.

On Lanzarote, we recommend booking accommodation in the centre of Arrecife. The whole island is a very popular tourist destination, and hotel rooms and apartments will be quite expensive - and 1-2 November will be a public holiday weekend. Room prices for 2 people start at around €450 (for 4 nights). Two well-known hotels near the waterfront in the city centre are listed below. Some hotels appear to be already heavily booked, but there are also many apartments in the area. In looking for accommodation, we suggest as a first step, that you look at Google Maps, or a major booking site such as Booking.com to see the locations of available properties.

> **Hotel Miramar** (3 Star), Avenida Coll, 2. 35500, Arrecife, Lanzarote
> Website: Hotel Miramar OFFICIAL WEBSITE | Lanzarote 3-star Hotel
>
> **Hotel Lancelot** (3 Star), Avenida Mancomunidad, 9, Arrecife
> Website: Official Website of Hotel Lancelot - Arrecife - Lanzarote

On Tenerife, we suggest booking accommodation that is within easy reach of the three Symposium venues in La Laguna (the Museum of Science, the Museum of History and the Plaza del Adelantado (town square) which is where field excursions will depart from (See map on page 5).

There is a wide range of guest houses, apartments, hostels and hotels in the area.

Hotel suggestions for La Laguna (all can be booked direct, or through booking sites such as Booking.com):

> **Aguere Nest Hostel**, Av. Leonardo Torriani, 1 - San Cristóbal de La Laguna
> Website: (Hostels in Tenerife| Nests Hostels)
>
> **Room 27,** C. Nuñez de la Peña, 27, 38203, La Laguna.
> Offers clean, comfortable double and triple rooms with shared bathroom facilities.
> Website: www.room27.es
>
> **Aguere Hotel** (2 star),
> Website: Home - Hotel Aguer
>
> **Laguna Nivaria Hotel** (4 Star)
> Website: Hotel Laguna Nivaria | San Cristóbal de La Laguna, Santa Cruz de Tenerife | Official website
>
> **La Laguna Gran Hotel** (4Star)
> Website: Boutique Hotel in San Cristóbal de La Laguna - Official web LLGH

Inter-island travel

For participants interested in doing the pre - symposium field excursion, a full day has been allowed for each inter-island transfer (Lanzarote-Tenerife).

We suggest travelling by air. There are two main airlines servicing the Canary Islands: CanaryFly and Binter Canarias, which is the larger and has more flight options.

For Tenerife, we suggest using Tenerife North Airport - Aeropuerto Tenerife Norte Los Rodeos (TFN), as it is much closer to La Laguna than Aeropuerto Tenerife Sur Reina Sofia (TFS). There are good bus connections between TFN and central La Laguna (a distance of about 3km). Alternatively, taxis are cheap (€10-12 for the journey) *view figure below..*

Inter-island travel by ferry is also possible. It is cheaper than flying, but it is slower and less convenient between distant islands.
For example, the Lanzarote-Tenerife ferry goes via Gran Canaria Island and takes a whole day. It's practic and cheaper to go to La Gomera (45 minutes), and to the westernmost islands if you are plenty of time.

Satellite Image of central La Laguna (Tenerife), showing ISV22 sites, several conveniently located hotels and the tram route between the city centre and the Science Museum.

An overview of the islands that will be hosting ISV activities.

The Canary Islands are located in the Atlantic Ocean about 100km (at the closest point) off the coast of Morocco. The archipelago comprises seven major islands and numerous smaller ones and is largely the result of volcanic eruptions over the past 70 million years. Initially, the eruptions were on the ocean floor, but geological evidence suggests islands started to emerge above the ocean surface about 20 million years ago.

The Canaries archipelago is an autonomous region of Spain and has a population of approximately 2.27 million inhabitants. The islands are a very popular year-round tourist destination, especially from Spain and other European countries. We have chosen the month of November for ISV22 as autumn is the best season for a period of calm and still very pleasant weather; it is after the end of the summer holiday season, but the weather will still be very enjoyable. It should be mostly dry and daytime temperatures of 23-26˚C are common.

Many visitors travel to the islands for the sun, beaches and diving. Others go to experience the fascinating blend of cultures, the local traditions, arts and festivals, or the rich flavors and traditions of the local cuisine and the very fine wines. For some, it is the attractions of nature, such as rugged volcanic landscapes and the endemic flora and fauna. For just a few, it is the caves.

and the tram route between the city centre and the Science Museum

Lanzarote

Lanzarote is one of the few places in the world where most different types of volcanic subterranean voids can be observed. The island hosts an exceptional variety of volcanic caves including lava conduits (pyroducts), anchialine caves (having a subterranean connection to the ocean), multilevel lava conduits, inflationary mono-trunk caves, complex labyrinthic pyroducts, lava and gas domes, magma-chamber caves, volcanic sea caves, lava lake caves, and more - all within an island measuring just 60 x 25 km.

Another major advantage is that all these features lie in an open, treeless landscape, free from dense vegetation, making them easy to locate and access.

As result of the year-round sunshine and its short distance from Europe, Lanzarote has become one of the most visited islands in the region. With a population of around 160,000 inhabitants, the pressure from more than 3.5 million visitors each year is enormous.

The island is now governed by strict regulations and an extensive permit system for many activities. In addition to being a UNESCO Global Geopark, Lanzarote includes national and international nature reserves. Rangers and substantial fines help enforce the protections. As a result, it is not easy for scientists or cavers to obtain access approvals for many sites.

The more than 250 caves on Lanzarote can be divided into several categories. The first consists of caves for which it is impossible to obtain access without a specific scientific research purpose (such as those in Timanfaya National Park). Another category lies on private land, where permission may be negotiated directly with the owners. A third category includes caves for which the Cabildo (local council) can grant permits. The fourth and final category covers caves located on malpaís - the island's barren volcanic badlands.

Tenerife

With almost 1 million inhabitants, Tenerife is the most populous island in the archipelago. It is also the largest island, covering an area of 2,034 km2. The triangular-shaped island is about 80km long and up to nearly 50 km wide. Most inhabitants live close to the coast, including in the two large cities of Santa Cruz de Tenerife (210, 000) on the northeast coast and San Cristóbal de La Laguna (160,000) which lies a short distance inland from Santa Cruz. Relatively few people live in the northeast corner of the island or in the rugged interior, dominated by Mt Teide (Pico del Teide), a strato-volcanic peak that last erupted in 1909. At 3,718m high, it is the highest point in the Canaries and of Spain. The mountain is in the 190 km2 Teide National Park, established in 1954 and in 2007, UNESCO declared the area as a World Heritage Site. ISV participants will spend a day in the park (details will be available later).

Cueva del Viento is the most widely known cave on the island. It is a complex pyroduct (lava tube) about 18 km long with multi-level areas and several collapse entrances. A short (200m) section on the edge of Icod de los Vinos is open to the public on guided tours. The cave is managed by the Organismo Autónomo de Museos y Centros (OAMC), the autonomous museums and centres organisation on Tenerife, which is supporting the ISV. For the field excursion, participants will be split into a number of groups and visit different sections of the cave. At least two or three of the groups will be taken to sections of Cueva del Viento that are somewhat difficult to pass through, with short narrow passages and crawling, suitable for participants who are comfortable with passages of medium difficulty. These parts can be considered as wild caves. Time and resources permitting, a group may be able to visit the Cueva de San Marcos on the coast of Icod. For participants seeking an 'easy' trip, the standard tourist trip will be available. This includes the show cave section and a guided walk through the surrounding forest to explore aspects of the local flora, fauna and ethnology.

Cueva del Viento. Image courtesy of Museos de Tenerife / Cabildo de Tenerife

Draft program

The dates in the following program are firm. However, amendments may be made to field trip details, in response to access approvals, party size limits and logistical considerations.

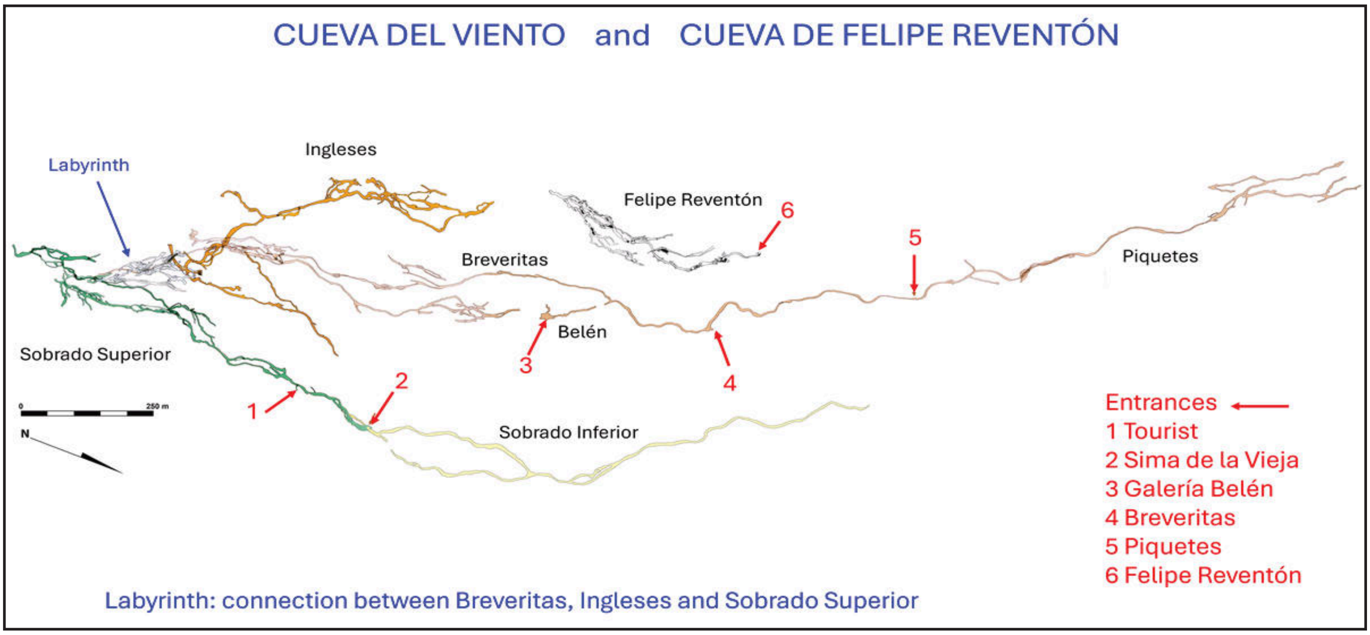
Optional pre-symposium field excursions on Lanzarote

Date	*Activity*	*Accommodation in*
Sat, 31 Oct	Arrive Lanzarote Evening: Optional get-together at a restaurant/ bar in the El Charco (lagoon) area of Arrecife (price not included in field trip fee).	Arrecife
Sun, 1 Nov	Lanzarote field trip, Day 1 – *All trips will depart from the GranHotel Arrecife.* **Trip 1.** Full day excursion for all participants to various surface and underground sites including Jameos del Agua (show cave) & exhibition on local caves and Mars/ lunar investigations and Cueva de los Verdes (show cave). *Maximum of 36 persons*. Entry fees (approx. €40) are not included, and participants must also provide their own lunches (Drinks and tapas can be purchased at Jameo del Agua).	Arrecife
Mon, 2 Nov	Field trip Day 2 (2 options) **Trip 2.** Cave trips for fit and experienced participants*. Full caving gear required and some caves will require use of SRT gear. *Maximum of 18 persons* and everyone must provide their own lunch. Estimated fees for the day €20. **Trip 3.** Visits to several surface and underground sites (Helmet and light required). Some sites have an entry fee that will need to be paid by participants (Estimated total for the day €20). Stop along the way for lunch (self-purchased). *Maximum of 18 persons on the bus, but more can participate if they have their own transport.*	Arrecife
Tue, 3 Nov	Field trip Day 3 (2 options) All participants will need to pay a €30 entrance fee to Timanfaya National Park. Discounts available for Spanish residents (ID required). **Trip 4.** Cave trips for fit and experienced participants*. Full caving gear required and some caves will require use of ropes. **Trip 5.** Visits to several volcanic sites, including in the Timanfaya National Park) Activities include an opportunity to walk to the rim of a volcano. Bring your own lunch or purchase it at a winery/ cellar door / bodega. *Maximum of 18 persons on the bus, but more can participate if they have their own transport.*	Arrecife
Wed, 4/11	Field trip participants transfer to Tenerife (self-booked).	La Laguna

*** For Lanzarote Trips 2 and 4,** trip leaders will assess each participant and will have the final say on whether or not they can enter each cave. This is for the safety of the participant as well as for the party as a whole.

Core ISV22 Activities on Tenerife

Date	*Activity*	*Accommodation in*
Wed, 4/11 (continued)	Arrive in Tenerife (Day free) Late afternoon: inscription of attendees and documentation. Welcome reception at Museo de Historia y Antropología de Tenerife (MHA) – the Museum of History.	La Laguna
Thu, 5/11	Presentation session (Day 1) at Museo de La Ciencia y El Cosmos (MCC), La Laguna. [A meeting of the UIS Commission of Volcanic Caves will form part of the presentation sessions on either this day or 7 Nov.]	La Laguna
Fri, 6/11	Field excursion to Teide National Park , travelling by bus, and departing from Plaza del Adelantado, across the road from the Laguna Nivaria Hotel. Optional excursion to a volcanic pit in Igueste de San Andrés, Anaga	La Laguna
Sat, 7/11	Presentation session (Day 2) at Museo de La Ciencia y El Cosmos (MCC), La Laguna.	La Laguna
Sun, 8/11	Field excursion to caves near the town of Icod de los Vinos, including Cueva del Viento. Participants will be split into small groups and there will be several trip options. Same transport arrangements as for the Friday excursion. Late afternoon: Symposium Dinner at a restaurant near the cave. Evening: Return to La Laguna by bus.	La Laguna

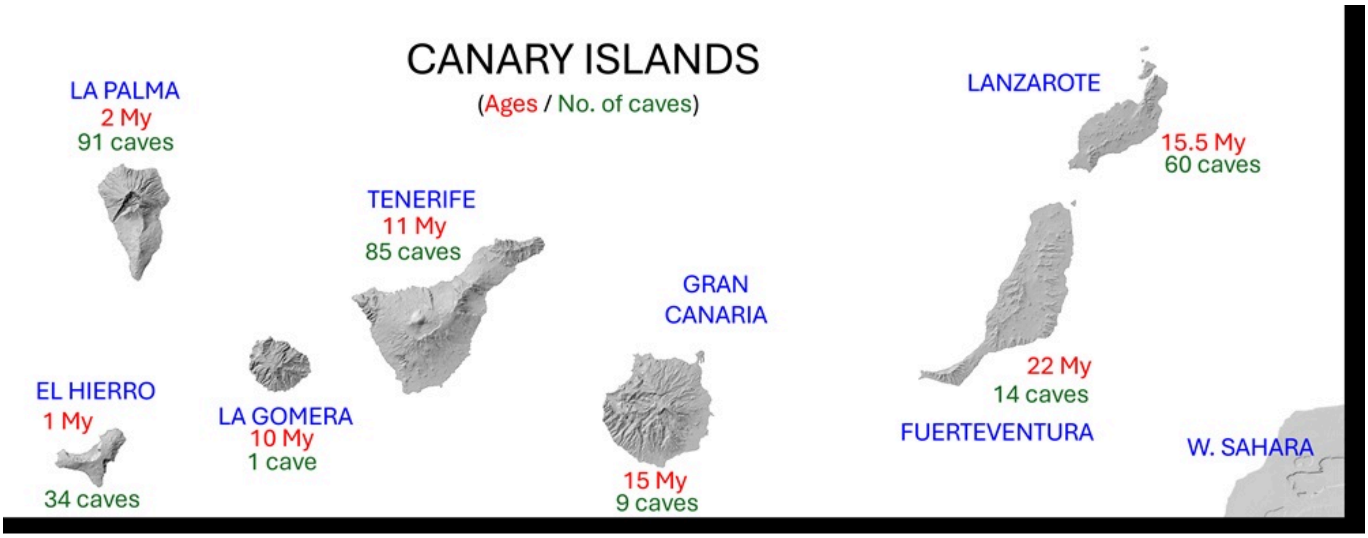


General information

The Canary Islands are located in the northeastern Atlantic, off the southern coast of Morocco, between 27º and 30º North latitude, and 13º to 18º West longitude. The closest island to the mainland is about 100 km away and the farthest about 500 km. The archipelago is made up of seven major inhabited islands and one islet, along with several smaller uninhabited islets. The major islands, from east to west, are Lanzarote, Fuerteventura, Gran Canaria, Tenerife, La Gomera, La Palma, and El Hierro. All are volcanic islands formed from a hotspot over which the African plate's oceanic crust has moved, so the eastern islands are older (Fuerteventura 21 Ma) and the western ones are younger (El Hierro 1 Ma). Volcanism is much more active in the western islands due to their proximity to the hotspot, so they are in an active growth phase and are much taller (1500 to 3700 m a.s.l.) and steeper, whereas the eastern islands are in an advanced erosive phase and are much lower (600 to 800 m). However, unlike other oceanic archipelagos such as Hawaii, the subsidence of the Canary Islands under the sea is very slow, they can remain emerged for longer, and volcanic activity has continued in recent or sub-recent periods in all but one (La Gomera), including those far from the hotspot. Thus, the easternmost, lowest and most eroded Lanzarote (15.5 Ma) underwent a short residual eruptive period that covered with lava a significant part of the island. There are abundant volcanic caves in the archipelago, especially pyroducts and some pits.

Since pyroducts tend to erode or get silted within a few hundred thousand years, they are abundant both on modern islands and on older ones with recent terrain. Thus, most of the caves are found in Lanzarote, Tenerife, La Palma, and El Hierro, very few in Fuerteventura and Gran Canaria, and none in La Gomera, that has not had volcanic activity over the last 2.5 Ma.

The climate is subtropical, with generally milder temperatures than in Mediterranean Europe, both in winter and summer. The NW trade winds dominate much of the seasons, and, aided by an upwelling of deep cold water between the eastern islands and Africa, they keep the temperatures relatively cool for their latitude. In any case, the high mountains of the central and western islands provide a strong climatic gradient, even with winter snowfall, especially on Tenerife (3,714 m) and La Palma (2,426 m). Additionally, they intercept the trade wind clouds so that the northern slopes are considerably wetter than the southern slopes. The high altitudes in relatively small areas result in different climatic zones, with dry scrub to open woodland with palm and dragon trees in the lowlands; humid subtropical laurel forest with broadleaf trees between 500 and 1400 m in coincidence with the trade wind belt; semi-dry endemic pine forest upon the cloud layer up to around 2000 m; and montane, dry shrublands on the top of Tenerife and La Palma islands. The flora and fauna are very diverse, with an endemism rate higher, together with Madeira islands, than that of any European region (25% of vascular plant species and 40 % of animal species).



History

The Canary Islands belong to Spain, but they were initially inhabited by an aboriginal people of Berber origin, the Guanches. It is estimated that they must have arrived shortly before our era, in a manner still unclear since they did not know how to navigate. There is archaeological evidence indicating the sporadic presence of Phoenicians and Romans on the eastern islands, but they never settled. The Crown of Castile began the colonization of the islands in 1402, starting with Lanzarote, and it was not completed until the definitive conquest of Tenerife in 1494. The Guanches were baptized with Spanish names and culturally assimilated, so that their language and customs disappeared. However, the majority of toponyms are of Guanche origin, and modern genetic studies show that the current Canary Islands population has a high percentage of haplotypes of Berber origin.

The archipelago is made up of two provinces: Las Palmas, which includes Gran Canaria, Fuerteventura, and Lanzarote, and the western province of Santa Cruz de Tenerife, including Tenerife, La Gomera, La Palma, and El Hierro. The islands are densely populated—particularly Gran Canaria and Tenerife—with more than 2.2 million permanent residents. In addition, the Canary Islands receive an exceptionally large floating population of around 18 million tourists per year (2025), corresponding on average to roughly 10 tourists per resident annually. On tourism-intensive but less populated islands such as Lanzarote and Fuerteventura, this ratio rises to up to 20 tourists per inhabitant, whereas the absolute numbers remain lower on the smaller western islands. This persistent influx exerts considerable demographic and environmental pressure, contributing to the progressive degradation of ecosystems that were still largely well preserved only a few decades ago.

Caving

As many as 285 volcanic caves (pyroducts longer than 50 m and pits deeper than 10 m) have been registered, most of them pyroducts but also some important deep pits (emptied chimneys or shrinkage cracks) and a few drained dykes. At least three of them have more than 7,000 metres of development: Cueva del Viento from Tenerife, Cueva de la Corona from Lanzarote and Cueva de Don Justo from El Hierro. Their age varies greatly, from those formed at the Tajogaite Volcano (La Palma) in 2021 to the Cueva del Llano (Fuerteventura), dated to about 900,000 bp. The caves are relatively warm, although variable (10ºC to 23ºC) depending on their altitude. The highest one is Cueva del Hielo (Tenerife) at 3340 m a.s.l., while Túnel de la Atlántida (Lanzarote) is almost completely submerged in the sea, reaching -60m deep. The adapted fauna is particularly diverse (around 300 troglobitic and stygobitic species) and highly interesting because of its endemism, being the richest among all volcanic areas in the world. The richest in cave-dwelling species (Cueva de Felipe Reventón, Cuevas del Corona) rival the continental karst caves in terms of diversity.


Cueva Felipe Reventón, Icod, Tenerife (© J.S. Socorro)


Cueva Sobrado, Icod, Tenerife (© I. Sasowski)


Cueva del Rincón, La Palma (© N. Duverlie))


Cueva de Máguez, Lanzarote (© L. de Graauw)


Sima de las Palomas, El Hierro (© N. Duverlie)


Cueva del Llano, Fuerteventura (© A. Lainez)


Cueva de los Verdes, Lanzarote (© J.S. Socorro)


Cueva del Viento (Breveritas), Icod, Tenerife (© J.S. Socorro)


Tunel de la Atlantida, Lanzarote, ©J.Lario
Below a link to a film of this cave:
https://canal.uned.es/video/6666b36baef0252fe14e2f55

Terrestrial caves have no permanent water currents or ponds, and very rarely have wet mud. Coveralls can be useful but they are not strictly necessary. There are laundromats for your clothes, in La Laguna (Tenerife) there is one very close to the Museum of Science - where the symposium will take place - and some more in the downtown. Long pants, knee pads, gloves and sturdy boots are highly recommended. It's advisable to bring some drinking water, especially for those that require effort due to their difficulty of progress. Due to the abundance of cracks in the surrounding rock, they are well ventilated and there is no danger of bad air; however, artificial mines drilled to obtain water can be dangerous due to gas emissions or low oxygen levels.

General Information

The official currency is the euro; credit cards can be used everywhere and there are ATM machines in every town. There are international airports on five of the islands, and domestic ones on the other two, and air connections are plentiful. There is good bus service throughout the territory, and in Tenerife there is an excellent tram connecting the urban area of Santa Cruz - La Laguna. There are many hotels and apartments, and plenty of restaurants. Hotel and restaurant prices are relatively cheap by Western countries standards. Car rental is particularly inexpensive, and fuel (1.1-1.2 €/litre) is much cheaper than in Europe.

Tap water is generally drinkable (at least in Tenerife and western islands), although it sometimes doesn't taste ideal. There usually aren't any digestive problems with meals. Typical canarian food is relatively simple and attractive, and it is based on the good quality of the ingredients. International food in very touristic places is not very interesting, better try to avoid it.


Corona system, Lanzarote, pict L. Smets


Corona system, Lanzarote, 3 levels, pict L. Smets

Islands with greater abundance of caves

Lanzarote

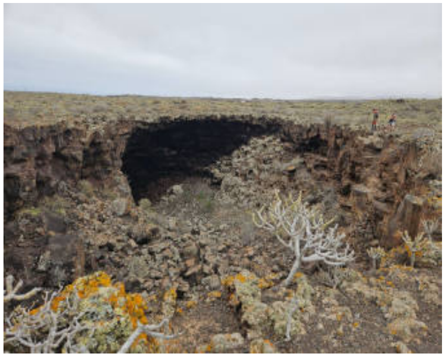
It has an area of 846 km² and is relatively low, with a maximum altitude of 670 m in the Famara Massif, at the northern end. It is the island with the most volcanic appearance, mainly due to the strong and continuous eruptions that occurred from 1730 to 1736, which covered 23% of the surface. More than 100 volcanos can be seen along the island. The most spectacular caves (total length 10 km) are those originated by Volcán de la Corona, including a) the huge pyroduct of Cueva de los Verdes; b) the Jameo de los Lagos, a XX long pyroduct with anchialine ponds at the lower end; c) the Jameos del Agua with an anchialine pond which has hundreds of blind, white crabs; and d) the Atlántida Tunnel which, starting from the latter, extends 1500 m under the sea. The first two have a section adapted as show caves, and they will be visited during ISV22, as well as other "wild" caves and many dramatic landscapes. Lanzarote has many other noteworthy peculiarities, such as traditional farming methods on volcanic soil in an arid climate, the excellent wine that is produced, the good fish, and so on.

Due to its concentration of caves and the variation in landscape over short distances, Lanzarote can be considered as a volcanic geological laboratory. Almost all volcanological and speleovolcanological phenomena can be found on Lanzarote. For some cave types (fumarole shafts, breakdown cavities in the still hot volcanic edifice, etc.) it can almost be considered even as a type location. Several of these types of caves will be visited during ISV22, like a monotrunk inflationary lava conduit, crusted-over multilateral lava conduits, some lava conduit-feeders, explosion chambers, volcanic sea caves and gas domes.

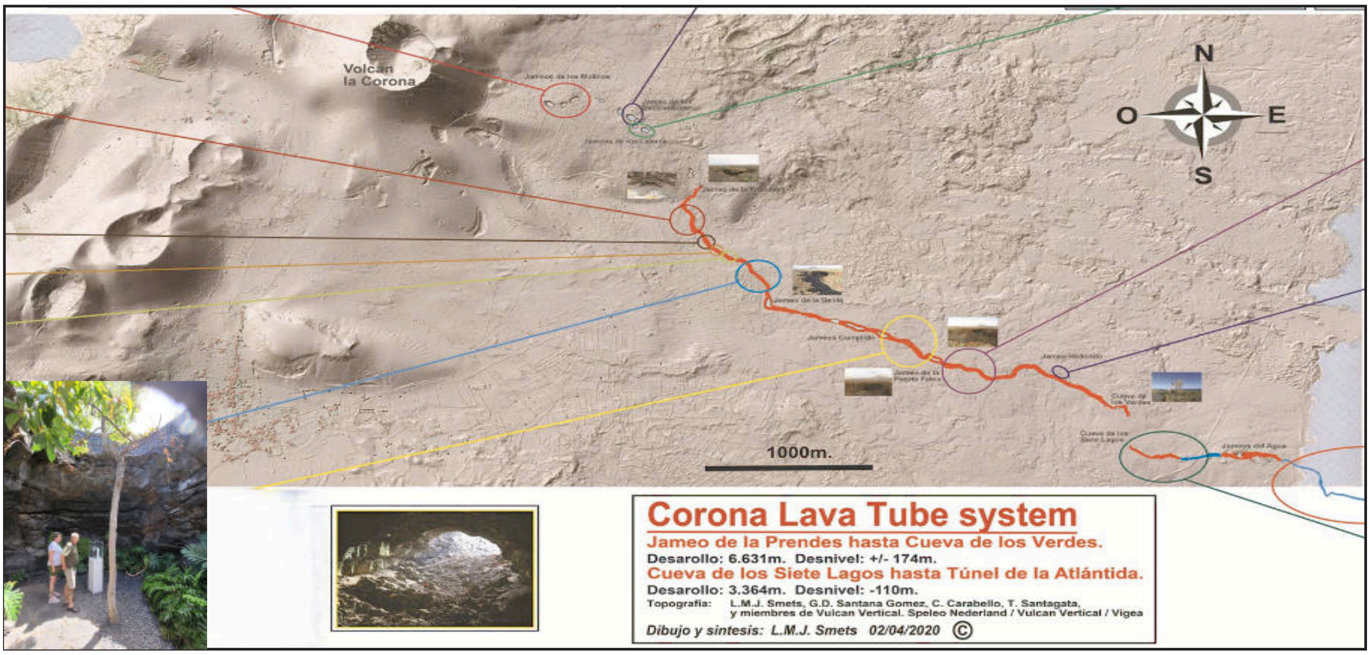
Museums such as the Fundación César Manrique in Tahiche, the museum at Jameos del Agua, and the visitor centre at Timanfaya National Park offer profound insights into the island's volcanic (underground) phenomena. Together, they provide a deeper understanding of the geological forces and lava formations that have shaped Lanzarote's unique landscape. All these will be visited during ISV22

Cueva de Maguez , at the right a small lavafall, pict by L. smets

Cueva Naturalistas pict L. de Graauw



Entrance of Jameo del la Gente (corona system), pict L. Smets



Tenerife

Tenerife is situated in the centre of the archipelago and is the largest (2033 km2), tallest (3718 m) and more diverse island in terms of landscapes and natural environments. At its NW (Teno) and NE (Anaga) corners there are two older areas with no volcanic activity in the past 4 million years. They have very rugged terrain with deep ravines and sharp ridges, the latter topped by subtropical humid forest; in Teno there are no caves and in Anaga only a volcanic pit. The centre of the island is more modern and elevated, with three mountain ranges that converge in an Y shape and correspond to the volcanic axes that built the island. Three mega landslides took place between 830Ma and 175Ma: two created the false valleys of Güímar and La Orotava; the third and largest landslide (170 ka) created the Icod valley, where volcanism reactivated strongly, building Pico Teide (3718 m) and closing the large caldera of Las Cañadas (approximately at 2000-2500 m), which makes up the National Park. The lava flows that descended from Teide towards Icod formed the most important pyroducts of the island, the largest of them being Cueva del Viento (17,500 m long). Tenerife has the greatest diversity of troglobites in the Canary Islands, with some highly adapted species. During ISV22, caves from both the National Park and the Icod area will be visited.

Cascada de Caliza Cueva del Viento, Tenerife, ©JSSocorro

Teide, N.P. view from the edge of the caldera, Tenerife,(© R. Oromí)

Roots in Cueva del Sobrado, Icod, Tenerife, (© D. Fröhlich)

Cueva del Sobrado, Icod, Tenerife (© J.S. Socorro)

Millenary dragon tree, Icod, Tenerife (© P. Oromí)

Entrance to Cuevas Negras I, Teide , Tenerife, N.P. (© P. Oromí)

Cueva del Calderón, Teide N.P., Tenerife, (© S. de la Cruz)

The island's capital is Santa Cruz de Tenerife (211,000 inhabitants), but from the Spanish conquest in 1494 until 1833 it was La Laguna, where the core of ISV22 will be held. The opening of the ISV will take place at the Museum of History, and the scientific symposium at the Museum of Science and Cosmos. La Laguna has a historic centre declared a World Heritage Site, with its main streets pedestrianized and very attractive, and a lively atmosphere with bars and restaurants. The City Council will offer an expert-guided tour on the history and artistic heritage of the city, and those interested will have free entry to Tenerife's museums, with particular interest in the Museum of Nature and Archaeology in Santa Cruz, where mummies of the Guanche people are kept.

Museum of Science and Cosmos, La Laguna, Tenerife (© P. Oromí)

Museum of History, La Laguna, Tenerife (© P. Oromí)

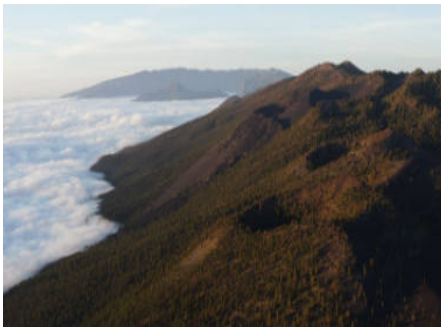
Town Hall buildings, La Laguna, Tenerife, (© P. Oromí)

La Palma

A medium size island (706 km2) with an area similar to that of Lanzarote, but much higher and wetter, with two different parts: the Palaeopalma at the north with a maximum age of 2 Ma and without recent or subrecent volcanism, dominated by a deep caldera with edges exceeding 2400 m, formed by a mega-landslide and subsequent volcanic construction that never closed the outlet to the sea to the west; and the Neopalma at the south, geologically much younger and structured along a north-south oriented ridge (Cumbre Vieja), with marked volcanic activity. It was here when the 2021 eruption of the Tajogaite volcano took place, in whose lava various pyroducts were formed. The highest rainfall in the archipelago occurs in La Palma. Its steep slopes and the depths of the caldera create spectacular landscapes. This is the island where a higher number of volcanic caves have been recorded.

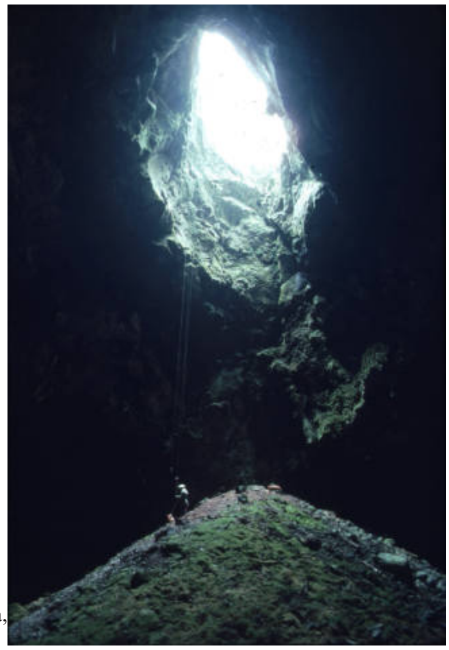
The total population is 84,000 inhabitants, and the capital, Santa Cruz de La Palma, is located on the east coast. The island has the largest banana production in the Canary Islands, especially on its western side, which is sunnier and has abundant water from the Caldera.

Unfortunately, the visit to La Palma previously scheduled as a post-symposium activity has had to be canceled.



The active ridge of Cumbre Vieja. Background: Palaeopalma and the Caldera (© P. Felipe)

Llano de los Cestos volcanic pit, La Palma (© N. Duverlie)



70 m deep Hoyo de la Sima, La Palma (© J.S. Socorro)

Eruption of Tajogaite volcano in 2021, La Palma (© P. Felipe)

El Hierro

It is the smallest (268 km²), youngest (1 million years old), and least populated (11,000 inhabitants) of the larger islands. Three massive landslides shape the island's subtriangular outline, the largest of which is known as El Golfo, offering one of the most dramatic panoramas in the Canary Islands. The climate is humid with high rainfall, but valleys have not yet formed, and due to the porous nature of the soil, there is no surface water. The last volcanic eruption took place in 2011-2012 and formed the Tagoro volcano under the sea, about 5 km south of the island and 900 m below the surface, without ever emerging. It is a very peaceful and welcoming island. More than 30 caves are known, the largest of which, Don Justo Cave at the southern end, is over 7200 m long. Two caves are adapted to public visits, but with free entry: Sima de Guinea, in the visitor centre and breeding farm of the El Hierro Giant lizard at Frontera, and Cueva del Acantilado at Orchilla lighthouse, the southwesternmost point of the island. Sima de las Palomas is an intersting volcanic pit connected with an inclined tube in its deep part.

Panoramic view of El Golfo, El Hierro (© P. Oromí)

Cueva Roja, El Hierro (© N. Duverlie)

Cueva de las Pardelas, El Hierro (© N. Duverlie)

We are looking forward to welcoming you to the Canary Islands in November this year.

Contacts

If you have any questions, please email us: info.isv22@gmail.com

Mt Teide, Tenerife. Image courtesy of: Museos de Tenerife / Cabildo de Tenerife.

Recent discoveries at Mt Porndon, Western Victoria

Author: John Brush

Introduction

Hidden beneath the lush pastures of the Pomborneit district of southwestern Victoria lie several short but impressive pyroducts that have remained largely unknown to the vulcanospeleological world. However, over the past two years an enthusiastic local part-time resident, who had become entranced with the caves, teamed up with a Victorian caving group and together they have documented the two known lava caves (or pyroducts*), rediscovered two long-forgotten caves and also found several new ones. The author was fortunate to have been invited to participate on two trips to the Mt Porndon area of Pomborneit in the latter half of 2025.

*the terms are used interchangeably in this article

Geology

The Mt Porndon area lies within the vast Newer Volcanic Province (NVP) which stretches westwards from Melbourne across western Victoria and into South Australia, a distance of around 400km. The NVP is an intra-plate continental basaltic province. Such provinces are widespread and are typically complex, long lived volcanic systems that consist of multiple, widely dispersed largely monogenetic volcanoes. More than 400 eruption sites have been identified across the NVP, which has been active over the last 6-8 million years (Cas, 2018). The most recent eruption was about 5000 years ago at Mt Shank in southeastern South Australia (Grimes, 2013). With an average eruption frequency of 15,000-20,000 years, the province is considered to be dormant, but still active.

Mt Porndon (fig 1) comprises a number of scoria cones sitting on a 'disc' of basaltic lavas about 3km across with a distinctive ring barrier (an abrupt change in slope) at the edge (Webb et al, 1993) The disc was interpreted to be sitting on extensive basaltic flows containing a number of caves.

Fig 1. Cave hunting in the Pomborneit area with the cinder cone of Mt Porndon visible in the background.

The age of the ring barrier basalts is around 116,000 years and the lavas beyond (containing the caves) are 260,000 - 300,000 years old.

History

Several pyroduct segments had long been known to the local farming community and, in all likelihood, would have been familiar to aboriginal people who have been living in the area for thousands of years. Vulcanologists had sporadically studied the area, for example Skeats and James (1937), and Ollier and Brown (1965). Ollier and Joyce (1968) mapped two caves and produced a paper before focusing their attention elsewhere. As far as the speleo community was concerned, the area was a curiosity, but with just two short but spacious pyroduct segments known, one of which was mined for guano and the other was used as a rubbish dump, there was there was limited interest. All the more so because it was often difficult obtaining access permission. However, these caves were well-known to local residents, who took a young lad named David Salter into Arch Cave on several occasions when he visited the area during school holidays and it sparked a latent interest that was to emerge several decades later.

Approximately two decades after those holiday visits, David bought a small block of land in the Pomborneit area and established a camp. It was a weekend retreat for his family away from life in busy Melbourne. Over the years David renewed acquaintances from his childhood days. In talking to locals about the volcanic landscape and its caves, that latent interest in caves emerged. David dug out a small entrance on his land, and he followed up on rumours about cave entrances being filled in many decades ago. Unsure of how to safely and softly investigate the caves, he joined the Victorian Speleological Association (VSA) and invited its members to visit 'his' area (Baeffel, 2024). Six months later, David joined the Commission on Volcanic Caves. After several trips to the area, David and his VSA colleagues have assisted trip leader Nigel Cooke resurvey the two main caves; re-enter two others that had their entrances blocked many decades ago; documented three short pyroduct segments; and explored several other unusual 'fissure' caves.

Caves

Porndon Arch Cave is perhaps the best-known cave in the area. It takes its name from a short remnant strip of roof about 3m in front of the cave entrance (fig 2). Beyond the entrance, the arch-shaped passage heads down slope (makai) and is generally 8-12m wide and 2-3m high. The floor is flat beyond some breakdown in the entrance area. Further in, the roof height progressively decreases to less than a metre before pinching out completely about 100 metres from the entrance.

The cave is a roosting site for the Southern Bent-Winged Bat *(Miniopterus orianae bassanii)* a listed critically endangered species.

Fig 2. Passing under the arch at the entrance to Porndon Arch Cave.

In order to minimise disturbance to the bats, cavers rarely enter the cave and if they do, their brief visits are conducted at night in fine weather after most bats have left the cave. While most of the guano was mined for fertilizer during the in the late 19th and early 20th Centuries, recent accumulations of guano and washed-in silt largely obscure the original pahoehoe floor.

Rubbish Cave is the other sizeable cave that has been known for a long time, but few people enter it. Sadly, the cave name accurately reflects the historic use of the cave. With no local rural rubbish collection service, the local community had used the large entrance puka as an informal tip for many years.

Access to the cave is through a small gap remaining between the puka wall and a steep unconsolidated slope. Beyond the entrance, the cave passage is approximately 90m long and some 4 to 12m wide. The passage is more than 5m high near the entrance but it soon reduces to a low, wide crawl (figs 3 & 4). A pile of breakdown boulders near the entrance, suggests the entrance is a cold collapse puka. Further into the cave, the original pahoehoe surface remains and most of the cave has an intact lining. In cross section, the floor arches up towards the centre of the passage and suggests that as the flow surface was solidifying, more lava was injected and inflated the still-plastic crust.

Fig 3. Looking down the passage in Rubbish Cave.

Fig 4. Trip leader Nigel Cooke ground truthing his survey near the low inner end of Rubbish Cave.

Skeats and James (1937) claimed the cave could at one time "be penetrated for more than 200 yards" (approx. 180m), but a collapse about six years before their visit blocked access. If this is so, it could not have been at the makai end, as there is no breakdown. If there had been a collapse in the mauka direction from the entrance puka, any evidence of it is now obscured. It is intriguing to think of what might be revealed if all the rubbish could be removed.

Aurora Cave was (re)discovered in March 2025 after David Salter guided a VSA party to an elongated closed depression. The depression was identified by a local resident, based on oral history passed down through the generations, as being the site where the entrance had filled in to prevent stock falling in. This was probably in the early days of the 20th Century. Selecting a promising area near the makai end of the depression, the VSA group started removing loose rocks and after three hours, they had managed to excavate an entrance large enough to allow entry (fig 5).

Fig 5. David Salter at the recently excavated entrance to Aurora Cave.

From this new entrance, it was an easy 3-4m descent to the cave floor over breakdown - and past several inflationary basalt layers that form the roof. Near the base of the climb a large cave passage could be seen leading away in the opposite (makai) direction to the closed depression, confirming their hunch that the depression resulted from collapse of a section of pyroduct. The passage was arch-shaped, some 6-8 m wide and up to 4m high. Away from the entrance, the original cave lining is largely intact, with very little breakdown lying on the flat pahoehoe floor, which is partly obscured by a thin coating of washed-in mud. The length of the cave is just over 100m. About halfway along the passage there is an area with a raised floor level (of 1-2m) extending across most of the width of the passage. This area appears to result from a combination of material falling from the roof while the cave was still hot and the ponding effect of the fallen material impeding the flow of lava. Beyond the raised area, the full-width passage continues, but the roof height reduces from around 3m to a low crawl before pinching out completely (fig 6).

Fig 6. Aurora Cave passage looking towards the entrance in the mauka (up-flow) direction.

The flat floor indicates lava in the cave failed to fully drain and lava rolls on both sides of the inner passage suggest there was sufficient heat in the pooled lava to partly remelt the wall linings, which in a plastic state, then peeled downwards under gravity.

There is also a large lava roll, perhaps more accurately described as a peel up to about a metre wide, along the eastern wall for the first 30 metres of passage beyond the entrance breakdown (Fig 7). Once again suggesting hot lava ponded in the cave for some time and partly remelted the lower section of wall.

Fig 7. Looking along the large lava rolls towards the inner end of Aurora Cave.

Missing Link Cave is another pyroduct segment where access was gained by removing loose rocks from the side of a closed depression (fig 8). In September 2025, the author participated on a VSA trip during which an entrance was opened to reveal the cave. After 5 or 6 hours of lifting and winching loose rocks, a vertical hole sufficiently large to climb through had been excavated (fig 9).

Up: Fig 8. Removing loose basalt boulders at the end of an elongated depression (a collapsed pyroduct segment) that led to the discovery of Missing Link Cave.

Right: Fig 9. The tight vertical entrance to Missing Link Cave, before it was backfilled with rocks.

That vertical entrance proved to be too narrow for all but the slimmest member of the party, but with the benefit of his 'inside knowledge', a larger entrance was soon opened up just a few metres away. The cave has less than 30m of passage, which is up to several metres wide and 3m high (fig 10). In the downflow direction, breakdown blocks the passage close to the location of the surface depression, but elsewhere, the walls and roof are intact. Near the mauka end, a smaller conduit joins the main passage, at which point there is a frozen lava cascade about 1.5m high (fig 11). The cascade appears to have been viscous and dammed the lava behind it. As it cooled, the ponded lava permanently blocked the side passage in the mauka direction about 10m from the top of the cascade.

Fig 10. The main passage in Missing Link Cave.

Fig 11. A "frozen" lava cascade emerging from the side passage in Missing Link Cave.

Before we left the area, the tight vertical entrance was filled in with rocks and the other entrance was covered over to prevent inquisitive stock stumbling in.

It is not known when the entrance to this cave was blocked. David Salter has been unable to find anyone in the local community who knew of the cave or had any record of when it was blocked or by whom. There were few signs of previous entry, apart from a hand-wrought iron spike about 20cm long driven into a wall crack and beside it, there is painted graffiti recording a visit on 21.4.79 by three people all of whom were Dicksons (fig 12), and we assumed they were related. We also initially assumed the date was 1979, but this is discussed in more detail below.

Fig 12. Painted graffiti in Missing Link Cave. The arrow points to an iron spike tightly inserted into a crevice.

Summary

All the above caves are likely to have been created from the same series of lava flows and they form a chain of segments along the same general alignment, as do two elongated closed depressions which are taken to be collapsed segments of the same system. All the caves show signs of ponding lava and essentially end in lava sumps.

Other caves

One Dome Cave is a 15m long pyroduct about 5-7m wide and has a maximum roof height of less than 2m. It is located close to the caves listed above, but its trend is perpendicular to that of the other caves, suggesting it may have formed either from a tributary flow, or at a different time to the others.

Skeats Cave and James Cave are both large collapse pits about 10m in diameter and 5m deep (fig 13). They both have sections of overhanging walls and one has two short dusty crawls, but there are no signs of any major passage in either direction. They are close together and are probably not related to any of the caves noted above.

Fig 13. Approaching the entrance to James Cave, which is little more than a collapse pit, or Puka.

Mars Cave was discovered by Reto Zollinger during the VSA trip in September 2025 and further investigated in November 2025. Its entrance is between basalt boulders (fig 14) on the raised rim of circular structure (fig 15) approximately 40m in diameter that has been described as a gas explosion crater (Skeats and James, 1937), but it appears to be much too large to have been formed by a gas explosion. Perhaps it results from roof collapse over a very wide pyroduct, but the mechanism for forming the raised rim (standing 1-2m above the surrounding ground surface and 2-3m above the floor of the central depression) remains unresolved. Further study is required.

Fig 14. Entrance to Mars Cave.

Fig 15. A section of the raised ring of basalt boulders surrounding a shallow depression.

The cave descends steeply between basalt boulders for several metres to a floor of earth and breakdown and there is a solid pyroduct wall on the side facing away from the ring structure above. The wall can be followed along a tight crawlway for several metres. In the other direction, a small passage in breakdown leads to a lower level where there is a short, low passage with an intact lining but all signs of the original floor are obscured by fine, dry cave fill (fig 16). In other words, the passage is a dusty crawl. Investigations are to be continued.

Fig 16. Low pyroduct passage beneath the basalt ring structure

Several other caves are also known. They are essentially vertically oriented 'fissure' caves several metres deep that are developed between large basalt boulders. Their origin is yet to be ascertained with any certainty.

Note: All of the pyroducts and fissure caves in the Mt Porndon area are on private property. If anyone is interested in visiting the area, they should contact VSA about participating on one of its regular visits to the area.

What can early cave graffiti tell us?

The painted graffiti found in Missing Link Cave recorded a visit by CT, EE and GC Dickson on 21.4.79 and, as the paint appeared to be reasonably fresh, the year was assumed to be 1979.

Several weeks after the Missing Link entrance was opened, David Salter noticed a photo of Porndon Arch Cave in the Proceedings of the Third International Symposium of Vulcanospeleology - ISV3 - (Webb et al, 1993). Close examination of the photo revealed graffiti by the same three members of the Dickson family but dated 19.8.93. This graffiti had not been not been noticed by anyone on the VSA trips in 2024 and 2025. However, it has now been located in the cave and while it is more faded than the Missing Link graffiti, it remains legible (fig 17).

Fig 17. David Salter at the faded 1893 graffiti in Porndon Arch Cave. It has the same 3 names as the 1879 graffiti in Missing Link Cave.
Photo by Heather Handley.

As ISV3 presentations took place in 1982 (although the Proceedings were not published until 1993), the photo very strongly suggests the graffiti dates from 1893 and if it is genuine, by extension the '79 date of the graffiti in Missing Link Cave must be 1879. This also sits more comfortably with the likely age of the hand-wrought iron spike found in that cave. Further evidence to support the authenticity of the dates has been provided by Maree Belyea from the local Camperdown Historic Society who has placed two of the Dicksons in the Pomborneit area in the late 19th Century by finding references to CT Dickson in the Colac Herald newspaper in 1888 and to EE Dickson in 1895.

Conclusions

The Mt Porndon area is relatively small and attracts only limited interest from vulcanologists and vulcanospeleologists, but the main pyroduct segments were known to the locals in the 19th Century. Renewed interest from the caving community over the past two years has resulted in some spectacular and intriguing discoveries and re-discoveries. Much more work remains in encouraging further vulcanological studies in the Mt Porndon, especially in dating the lava flows that produced the pyroducts. There is considerable scope for additional documentation of the known pyroducts and for following up other leads. The main pyroduct segments appear to be part of the same system, and there is potential for finding more 'missing links' along the system. However, the presence of elongated surface depressions (suggesting the presence beneath of a collapsed segments), coupled with the fact that most of the large segments end in the makai (down-flow) direction in lava sumps (indicating passages that have not fully drained) strongly suggest that the chances of physically connecting all the segments with underground routes is a pipe dream. But dreaming about underground pipes surely cannot be a bad thing.

Acknowledgements

The author is indebted to David Salter for the invitation to participate on two trips to the Mt Porndon area during 2025 and also thanks David and his wife Wendy for their warm hospitality in Pomborneit and Melbourne.

Thanks are also due to Nigel Cooke who very capably led the large VSA trip in September 2025 as well as the small trip in November 2025 that was arranged at short notice to take advantage of my wife and I being in the general area (ie, within 250km) for another purpose.

In addition. I acknowledge Maree Belyea, a member of the Camperdown Historic Society, who was very helpful to David Salter in tracking down records of the Dickson family that successfully placed them in the Pomborneit area during the latter half of the 19th Century and in doing so, effectively authenticated the dates of the graffiti in Porndon Arch and Missing Link Caves.

All photos are by the author, unless stated otherwise.

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The use of self-tapping concrete screws in Volcanic rock

*By Laurens Smets**
*Co-author: Albert Neumann***

When people talk about volcanic caves, most tend to think of lava tubes — horizontal, easy-to-explore tunnels formed by flowing lava. What usually doesn't come to mind are shafts, lava falls, deep dolines, and volcanic craters. In these cases, cave exploration often involves vertical access, requiring rope techniques and ……the use of rock anchors.

Unlike limestone, volcanic rock is generally not homogeneous in structure. Lava flows typically consist of many different layers welded together, each representing the varying consistency of lava material emitted by the volcano at different times. Some layers are thin; one may be as hard as glass on the outside, while the interior contains only soft ash or welded clasts. In other cases, the lava is solid and hard all the way down but full of cracks — as is often the case with ʻAʻā lava. Or, the lava may be full of air- and gas bubbles, forming rock that is hard on the outside but full of cavities inside, which is typically the case with pāhoehoe lava.

This means that, unlike most limestones, volcanic rock has a highly inconsistent structure — its quality can vary every 10 centimeters. This variability forms the basis for the challenges faced when installing self tapping screw anchors for descending into volcanic shafts.

In practice, conditions are often demanding, and cavers continually push the limits — as they do, for example, in some parts of the Canary Islands. Many volcanic shaft caves can be found there: some are fumaroles, others are remnants of magma chambers, and some are simply pressure-release vents from lava conduits.

In several vertical caves, you can find empty drill holes at locations where anchors would normally be expected above the shafts. These holes are intended for re-use when installing self-tapping screw anchors, which are typically 8 mm in diameter.

How safe this practice actually is — or isn't — is the question we aim to address in this article. Several investigations and publications have already explored this topic in the past, notably in 2018 and 2019. See: https://cncc.org.uk/file/3aa51cae-4851-c59a-1f42-93e366425a6e from Simon Wilson, a translated publication in Stalactite 68 2019 by Rolf Siegenthaler (SGH Bern), and Florian Hof (SCVJ) http://bergimpuls.ch/assets/files/Betonschrauben-E.pdf and https://cncc.org.uk/file/a8a27a96-d649-f6a2-a9b4-2c402f60b8c1 with " the title Concrete screws – testing for caving use" from Ian Walker, 02/04/2024.

The 2 first mentioned investigations were carried out in limestone and, in both reports, the authors strongly recommended that this type of anchor be used only by adequately experienced cavers — and <u>for exploration only!</u>

However, neither report investigated the re-use of existing drill holes with different brands or models of screw anchors. Nor did they address the use of these anchors in rock types other than limestone. Therefore, the safety of using self-tapping screw anchors — and especially the re-use of pre-drilled holes — in volcanic rock remains an open question.

Volcanic cavers in the past always have been aware of the challenges associated while installing anchors in volcanic rock. Traditionally, expansion anchors have been the most commonly used type in this setting. These anchors work under tension, and their reliability can be assessed by checking whether a specific tightening torque is achieved.

In more recent years, chemically bonded anchors have become increasingly popular. When made of stainless steel, they can offer long-term durability. However, even these are not immune to the harsh conditions often found in volcanic environments, where wear, corrosion, and mechanical stress can significantly reduce anchor lifespan..

Most of the problems associated with anchors on the short and long term in Volcanic rock are:

- Aggressive volcanic cave environments caused by minerals such as salts, sulfur, and chlorides.
- Inconsistent composition of the rock with mixing layers of soft and hard material, welded clasts, and ash particles (e.g., glassy outer crusts with softer interiors).
- Air-filled rock, ranging from fine porous textures to larger hidden cavities not visible from the outside
- Cracks resulting from the lava's cooling process, as well as pressure fractures, tectonic cracks, fissures caused by vibration, shifting of layers, or earthquakes.

In this study, we re-consider the safe use of self-tapping screw anchors, which have become widely adopted in the caving community over the past decade and are now being introduced into volcanic environments.

The main question of our investigation is whether these self-tapping concrete screws are suitable for use in volcanic rock — and, furthermore, whether pre-drilled holes can be safely re-used, as is currently practiced in some regions of Spain.

To our knowledge, the most commonly used self-tapping screw anchors are the Fischer FBS II US 8 × 70 and the Heco Multi-Monti (MS) 10 × 60.

Figure 1: examples of the Fischer and Heco self-tapping screw anchors.

Both models require an 8 mm drill hole. Fischer calls its model by the drill-hole diameter (8), whereas Heco labels its product according to the diameter of the anchor rod (10) — which can be somewhat confusing.

The choice to use one type of anchor with a 70 mm shaft and the other with a 60 mm shaft was based primarily on product availability at the time of testing. Additionally, Fischer does not offer a 60 mm version of this self-tapping screw anchor with a hexagonal head

Some facts:

Both anchors require the drill hole to be at least 10 mm deeper than the length of the anchor shaft. After drilling, the holes must be cleaned of dust, (cleaning with air). The rock surface where the anchor is placed must have a consistent composition , being suitable and hard (strong) enough to support this type of anchor; and…. Installation should only be carried out by experienced cavers who have the necessary skills to assess and judge whether the surface is suitable for installing a self-tapping screw anchor — by observation, feel, and understanding the characteristics of this specific rock.

In next list the measured dimensions are presented of several randomly selected self-tapping screw anchors used in this study. (figure 2 dimensions of the tested self-tapping screw anchors: Heco MMS 10 x 60 and Fischer FBSII US 8 x 70)

	Heco MMS 10 x 60	Fischer FBSII US 8 x 70
diam. internal tapered in mm.*	7,34 - 7,5	7,5 – 7,5
diam. external tapered in mm.*	9,6 -10,3	9,7- 10,1
amount of serrated first thread pitches	4	2,5
amount of thread pitches per 60mm.	10	8
distance of thread pitches in mm.	6,15	8,10
* all dimensions are measured on a random chosen screws and can differentiate tenth of milometers within one production batch		

Figure 2a : dimensions of the tested self-tapping screw anchors

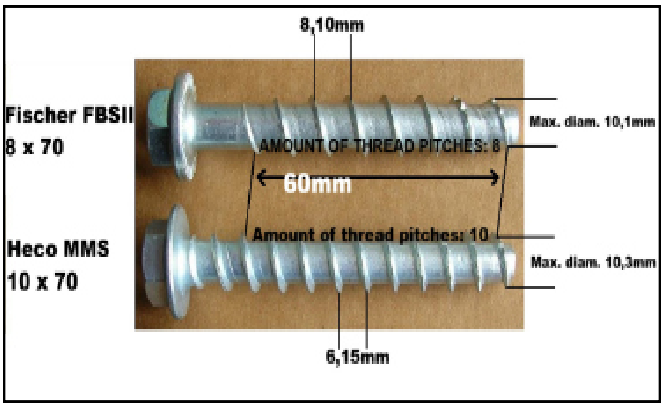


Figure 2b: Fischer FBSII 8 x 70 anchor and Heco MMS 10 x 70 anchor

As can be seen in Figure 2a and 2b, the dimensions of these examples of commonly used anchor brands vary significantly. Although size differences of only a few tenths of a millimeter may occur even within the same production batch, the overall observation is that the Fischer FBS II 8 × 70 and the Heco MMS 10 × 70 have no identical dimensions at all. Even the hexagonal heads differ: the Fischer requires a 13 mm spanner, while the Heco needs a 17 mm spanner. The thread geometry also varies — Fischer has 8 thread pitches over a distance of 60 mm , whereas Heco has 10 pitches over the same length. In addition, both the inner and outer thread diameters differ slightly. Although these differences are only in the order of tenths of a millimeter, such variations are significant in the context of steel threading and can directly influence compatibility and performance.

The testing:

Our testing ground for the anchors was Lanzarote, one of the eight Canary Islands. The island offers a wide range of volcanic rock types — plus good food and constant sunshine. It also features numerous vertical caves, and on top of that reliable anchoring systems could be highly valuable for the many barrancos (canyons) found on the island, some of which reach depths of over 400 meters.

Because of the great diversity of types of lava present on Lanzarote, we were able to test the reliability of anchors in various environments. The goal was not to cover all types of volcanic rock worldwide, but rather to provide additional insight and raise awareness among cavers about the potential false sense of security when using this type of anchors in volcanic rock. To simulate real-life conditions, we selected several test locations on abandoned lava fields where multiple types of lava rock can be found equal to the volcanic rock near to caves. In line with the European standard EN 795 we conducted axial pull-out tests.

While this axial directed testing method not fully represents the actual load direction typically experienced by anchors in practice (which is usually shear loading), it is accepted in standardization protocols as an appropriate method to evaluate the installation soundness of fall-arrest anchors. The columns in Figure 3 show the results of the many pull-out tests that were conducted.

		TESTING SCREW ANCHORS: Fischer FBSII US 8 x 70 and Heco MMS 10 x 60 : drillhole 8mm.							
1		A	TEST B	TEST C	TEST D	Additional TEST E, Failure test			
Type of anchor		Type of volcanic rock	1 x Use test, 6Kn.	2x Re-use same drill hole/ same anchor as in column 1. 6KN test. **	Re-use same drill hole with FBS anchor + successive MMS 10 x 60 anchor. 6Kn. Test **		OK? Y/N	Remarks	Location
									LANZAROTE
Fischer FBSII US 8 x 70	1	black basalt rock	OK	OK	6Kn. 1x test FBS + 1 x test MMS	MMS Pulls out at 8Kn.	Y	After Test D Bolt is moving back and forth	C Carmelo
Fischer FBSII US 8 x 70	2	slab-crusted flow lava	Failure 4kn.	xxx	xxx	xxx	N	FBS anchor pulls out slab	C. Carmelo
Fischer FBSII US 8 x 70	3	On top of Pahoehoe lava	Failure 1kn	xxx	xxx	xxx	N	Test B results in cracks and pull out at 1kn	C. Naturalistas
Fischer FBSII US 8 x 70	4	On top of Pahoehoe lava	OK	Failure	FBS-test OK. MMS-test Failure. MMS causes stripped drill hole, cannot be fastened	xxx	N	Test C: after 2 x pulltest FBS moves 3mm. Outwards.	C. Naturalistas
Heco MMS 10 x 60	5	On top of Pahoehoe lava	OK comes out 1mm	OK, MMS is moving back and forth	MMS test OK. FBS-test OK (bolt comes out 4mm)	xxx	Y/N	Dubious results. Holes cannot be re-used!	C. Naturalistas
Fischer FBSII US 8 x 70	6	On top of Pahoehoe lava	OK comes out 2mm.	OK, comes out 5mm.	MMS-test Failure. MMS causes stripped drill hole, cannot be fastened	xxx	N		C. Naturalistas
Fischer FBSII US 8 x 70	7	at side of Pahoehoe layer	OK	Before use: cleaning hole by air. Failure 5Kn.	xxx	xxx	N		C. Naturalistas
Fischer FBSII US 8 x 70	8	at side of Pahoehoe layer	OK	Failure 5,5kn.	xxx	xxx	N		C. Naturalistas
Heco MMS 10 x 60	9	at side of Pahoehoe layer	OK comes out 3mm, bended head	Failure 2kn.,	xxx	xxx	N		C. Naturalistas
Fischer FBSII US 8 x 70	10	welded AA lava	OK	OK	2 x FBS test OK, 1 x MMS Failure 6kn	xxx	Y/N	re-use is dubious	C. Gentes
Heco MMS 10 x 60	11	welded AA lava	OK	OK	OK	xxx	Y		C. Gentes
Fischer FBSII US 8 x 70	12	welded AA lava	OK	OK	OK	MMS Failure at 8Kn.	Y	Test E = pull out	C. Gentes
Fischer FBSII US 8 x 70	13	welded AA lava	OK	OK	2 x FBS test OK, 1 x MMS Failure 5kn		Y/N	re-use is dubious	C. Gentes
Fischer FBSII US 8 x 70	14	hydrothermal alterated black basalt ***	OK	OK	OK comes out 1mm.,	Failure at 9Kn.	Y		C. Tinguaton
Fischer FBSII US 8 x 70	15	hydrothermal alterated black basalt	xxx	xxx	xxx	xxx	xxx	Rock is too hard. Anchors get stuck halfway	C. Tinguaton
Fischer FBSII US 8 x 70	16	clasted basalt (welded small rocks)	Failure at 4Kn.	xxx	xxx	xxx	N		C. Tinguaton
Heco MMS 10 x 60	17	hydrothermal alterated basalt walls of Geysir	OK	OK	2x MMS OK, FBS cannot be screwd in (rock too hard)	xxx	Y	Rock is too hard for FBS, Steel of MMS is weaker material	C. Tinguaton

** before re-use of the holes , these were not cleaned out by air, unless stated in the test results

*** hydrothermal alterated black basalt can be found near fumaroles and former Geysir shafts. This particular rock has a hard glassy toplayer, more soft inside, no airbubles inside and of a very homogeneous nature. The basalt of the walls of fumarolles and Geysir shafst is alterated due to the high temperature and chemical alteration causing the walls to become in some case as hard as glass

Fig. 3 overview on the test which have been done with their results. Failures in red colour

The tests where performed in abandoned areas which had signs of former mining and disturbance of the geological landscape. After the tests were finished, the bolts were removed and the remaining drill holes were closed with the surrounding rock particles

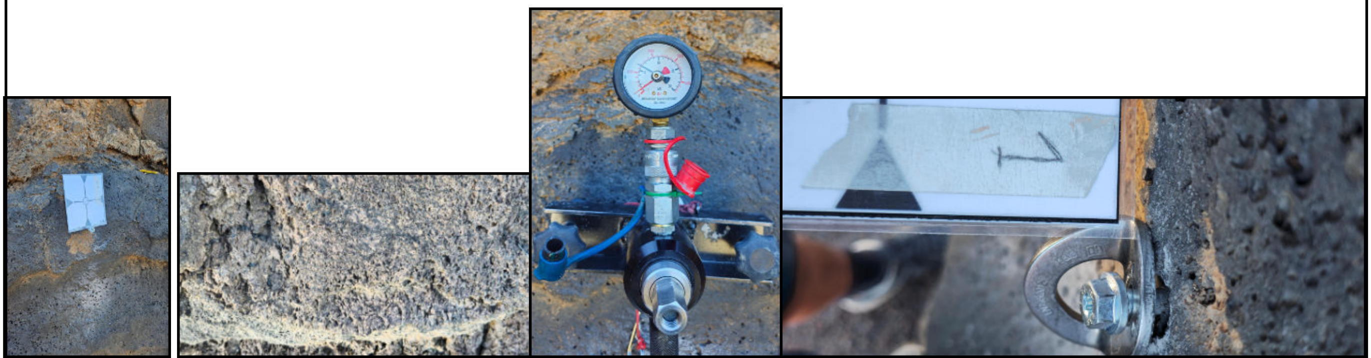
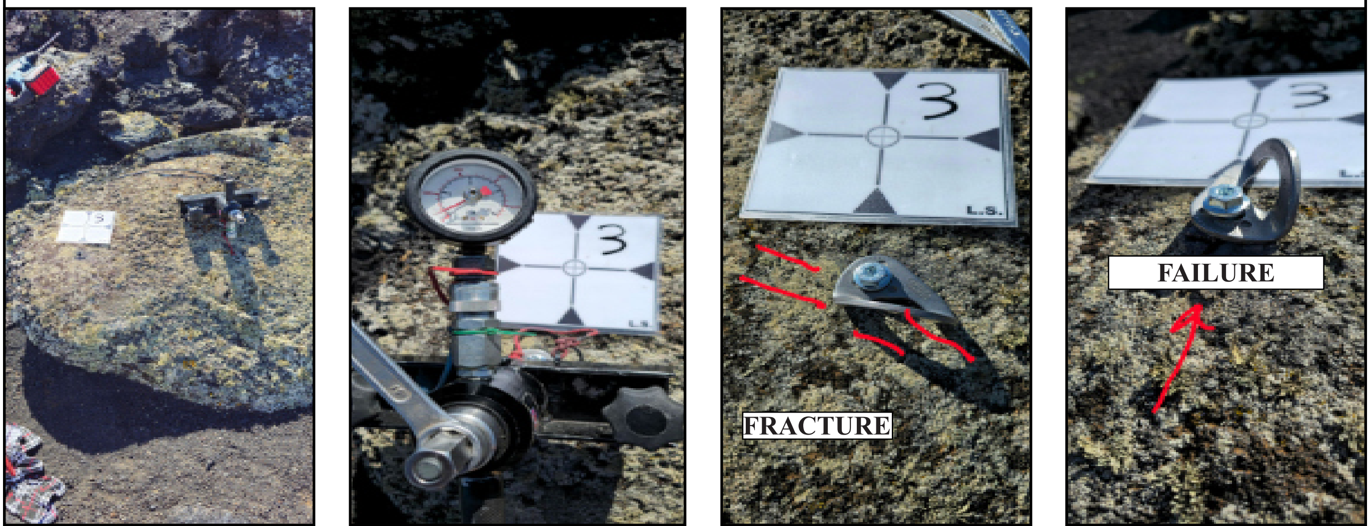


Figure 4 (a–d). Overview of test site 1, showing the black basalt rock type, the 6 kN pull-out test setup, and the observed movement at test (in column) D under an 8 kN load.

Fig. 5a, b, c and d, Showing location of test site 2, type of slab crusted lava flow, cracks and failure at 4kn



Location of the anchor

Fig. 6a, b, c and d, Showing location of test site 3, on top of Pahoehoe lava, cracks and failure at 1kn

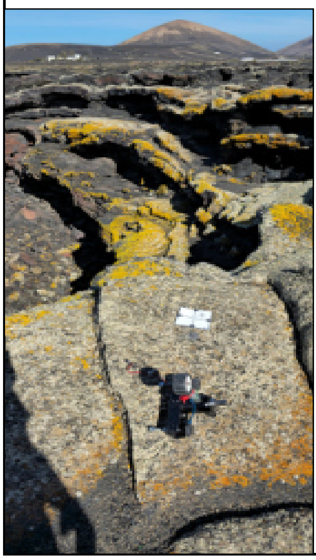


Fig.6e showing the similar test site situation of test 3 and 4

Fig. 7a, 7b and 7c showing location of test site 7: At the side of a Homogeneous looking pahoehoe lava slab .
Fig. 7d showing failure at 5Kn. at second time re-use of the same anchor.

Fig. 8a – 8c showing the location of test 13, welded AA lava Fig. 8d showing failure at 5Kn at second time re-use of the hole by a MMS anchor

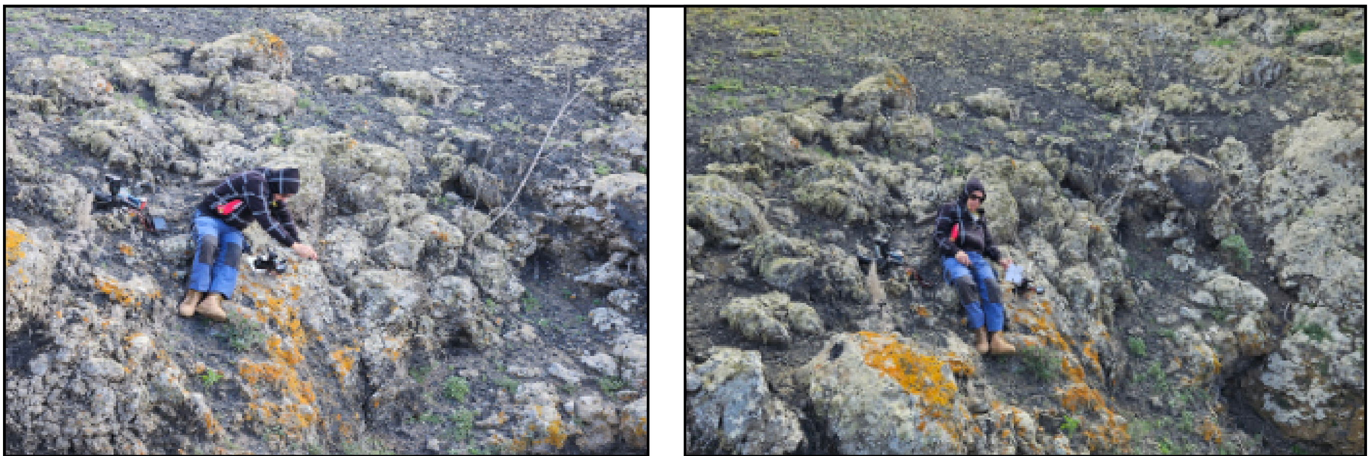


Fig. 9a – 9c showing the location of test 16, clasted basalt (welded small rocks). Failure at 4Kn.

Conclusion:

Re-use of self-tapping screws presents several problems. One key factor is whether the drill hole is properly cleaned with air before re-use. If the hole is not cleaned, sand and fine rock particles remain inside and can damage the threads, leading to degradation of the thread profile and a significant reduction in the anchor's holding strength after re-installation.

In our observations, the Heco MMS anchors are notably softer than the Fischer FBS II. The threads of the Heco MMS are weaker, and the bolts themselves are more easy to bend.

According to the previously mentioned investigation reports, screw anchors are not suitable for multiple use in regularly visited caves. Pre-drilled holes are designed for single use only. Re-using them can damage the threaded surface due to dust and small rock particles remaining in the hole. Even when using anchors of the same brand but different pre-manufactured lengths, the threaded hole may still be compromised, as the number and geometry of the serrated lead threads differ between bolt sizes.

Mixing different brands of screw anchors in a previously used hole can seriously compromise the reliability of the installation. Each manufacturer produces anchors with slightly different thread pitch spacing and diameter, which will damage the existing threads within the hole and result in a loss of anchoring strength in the rock.

1) Re-use

Re-use of self-tapping screw anchors in volcanic rock is not recommended, unless reliable backup anchors are in place, the rock is of high density and homogeneous structure, and you are 100% confident in the strength and integrity of the installed anchor in the re-used hole.

The use of newly drilled and installed self-tapping screw anchors in volcanic rock can be considered as an effective solution while exploring — provided that several safety measures are followed. Multiple anchors should always be installed, and the rock must be carefully inspected for cracks, consistency, hardness and structural soundness.

During drilling, the installer must continuously assess whether the rock feels solid and compact, free of air or gas bubbles, and provides a steady and reliable drilling response — something that only an experienced installer can accurately judge. After drilling, the hole should be thoroughly cleaned with air. When tightening the self-tapping screw anchor, the tapping process should feel firm and consistent throughout.

The only practical way to verify the soundness of the installation is by achieving the appropriate tightening torque once the anchor head is fully seated against the hanger.

2) Use Conditions

Yes, self-tapping screw anchors can be used in certain types of volcanic rock, but only under specific and controlled conditions:

- - For exploration purposes only, and limited to one-time use.
- - Installation must be performed exclusively by experienced users familiar with self-tapping screw anchors
- - Anchors should be placed only in solid, homogeneous, and reliable rock which is considered strong and dens enough during drilling
- - Anchors should be loaded in shear direction only, not subjected to axial pull-out forces.

3) Installer Competence .

The caver must be experienced in installing this type of anchor and he possesses the necessary skills to assess — by sound, observation and feel — whether the rock surface is suitable for installation. He must also have the skills and experience to determine whether the installed anchor is sufficiently reliable or if additional backup anchors are required. It is important to note that no practical on-site method exists to directly verify the strength or reliability of this type of anchor once installed.

It should be clear to everyone that natural anchors are always the first choice when installing rope or ladder systems. Only when natural anchors are unavailable or appear unreliable should bolts and hangers be used.

* *The author has been a manufacturer of anchors and anchor systems used in industrial fall arrest for more than 15 years. Furthermore, he has been working for over 10 years in European standardization working groups dealing with industrial and recreational fall arrest systems.*
** *The co-author has been a technical leading engineer for more than 50 years*

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The Proceedings of the 19th International Congress of Speleology 38° Congresso Brasileiro de Espeleologia 2025

An overview on the volcano speleology related subjects published in the proceedings of the 38 UIS Congress.

Session 13

Geoheritage values and conservation of the Billemot Cave in Jeju Island, South Korea

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Abstract

Cave is a labyrinth-type, multi-levelled lava tube cave which is approximately 10,050 m in length. This cave was considered as a strong candidate for extensional World Heritage Site. It exhibits a braided maze form, predominantly developing in one direction, with pathways intri-cately divided by numerous lava pillars of varying sizes. Inside the cave, various lava speleothems and micro-topographic features enhance its geoheritage values. Especially notable are the lava speleothems such as tubular lava helictites, cylindrical lava stalactites (up to about 20 cm long), and lava stalagmites (approximately 75 cm high). Additionally, diverse micro-topographic features further elevate its geoheritage significance. The cave also contains numerous secondary speleothems composed of opaline silica, enhancing its scenic value. Sediment deposits up to about 2 meters thick, have been transported through small cracks in the cave ceiling. They span approximately 1.4 km and may serve as a potential indicator for tracing paleoclimate. Numerous vertebrate skeletons, presumed to be from cats or badgers, have been found above the sediment deposits. Also known are the other animal bone fossils, including those of brown bears, red deer, and roe deer, which are estimated to be Paleolithic in age. To conserve the geoheritage value of the cave, the Jeju Special Self-Governing Province conducted environmental restoration as well as extensive surveys. This involved removing all graffiti and various waste materials to restore its integrity.

The complete report you can find on: https://uis-speleo.org/index.php/proceedings-of-the-international-congress-of-speleology-ics/ look for Volume 5 page 147 – 153

Morphometric analysis of lava tubes.

By: Alessandro Marraffa (1), Matteo Massironi (1 2), Riccardo Pozzobon (1 2 3) & Francesco Sauro (1)

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(3) Dipartimento di Fisica e Astronomia, University of Padova, Italy

Abstract

Lava tubes are objects of great interest not only for their role in the formation of lava flow fields on Earth but also for their implications on the emplacement of lava terrains across the Solar System. These features have been detected on the surface of Mars and the Moon through satellite imagery as sinuous collapse chains interpreted as surface evidence of subsurface conduits. To date, subsurface conduits have not been observed yet. Indeed, through the study of terrestrial analogues, it is possible to infer the potential lava tube morphologies beneath the surface of Mars and the Moon. Different authors have proposed possible morphometrics indices to describe the genetic features of some particular karst caves. Here, we

have applied the same approach to terrestrial lava tubes. Digitizing lava tube surveys in several sites all over the world allowed us to extract dimensional parameters and gather them in a global database. Lava tubes on Earth have different morphologies and sizes, potentially associated with specific eruptive (effusion rates, trend and duration of the eruption) and slope parameters. In this work through the correlation of all the variables, we had obtained useful information to understand lava tube genetic processes and their evolution on Earth and possibly on other planetary bodies.

The complete report you can find on: https://uis-speleo.org/index.php/proceedings-of-the-international-congress-of-speleology-ics/ look for Volume 5 Page 154-157

The Hraunrásir project: exploring the mineralogy, microbiology and evolution of newly formed lava tubes in Iceland

By: Francesco Sauro (1,2), Tommaso Santagata (1,3), Martina Cappelletti (1,4), Ettore Lopo (4), Ana-Zelia Miller (5), Bogdan P. Onac (6), Ada De Matteo (1, 7), Gro Birkefeldt Moller Pedersen (8), Marco Vattano (1), Giovanni Rossi (1), Riccardo Pozzobon (1,2)

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Abstract

The 2021 Fagradalsfjall eruption (March 19–September 18) provided a rare opportunity to study shield volcano emplacement in real time. Lava tubes played a crucial role in lava transport and field buildup, as documented through webcam videos, photos, and aerial photogrammetry. One year post-eruption, cooling lava tubes became accessible, allowing the Hruanrásir Project to investigate their formation, evolution, mineralization, and microbial colonization. Expeditions (October 2021–May 2024) revealed key findings: (1) magnetometry and 3D morphometry helped reconstruct lava tube emplacement; (2) at least nine metastable secondary minerals, some previously undescribed in lava tubes or Iceland, were identified at varying temperatures; (3) extremophile microbial life was detected in cooling tubes (70°–40°C), indicating rapid colonization within 20 months post-eruption.

These results enhance our understanding of lava tube genesis, cooling processes, and early microbial colonization, with implications for planetary studies.

The complete report you can find on: https://uis-speleo.org/index.php/proceedings-of-the-international-congress-of-speleology-ics/ look for Volume 5 Page 158-162|

Morphology and microclimate of a notable glaciovolcanic cave, Mount Meager, Canada

By: Christian Stenner (1), Kathleen Graham (1), Michael Paton (2), Jeremy Nash (2), Morgan L. Cable (2), Glyn Williams-Jones (3)

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(3) Centre for Natural Hazards Research, Department of Earth Sciences, Simon Fraser University, BC, Canada

Abstract

Within the Garibaldi Volcanic Belt, British Columbia, lies Mount Meager Volcanic Complex (Qwelq̓welústen), a glaciated volcanic massif which last erupted approximately 2360 a. B.P. A novel glaciovolcanic cave system was first observed in the Job Glacier at Qwelq̓welústen in 2016. Exploration was enabled by hybrid Self-Contained Breathing Apparatus (SCBA), while combined LiDAR and survey data revealed cave morpho-logy. Investigations revealed the geothermal emissions and microclimate which shaped glaciovolcanic cave geomorphology.

The cave was formed from thermal flux originating from subglacial fumaroles and heated ground surfaces in the underlying edifice, combined with glacial ablation, which melted channels through the ice to the glacier surface. Subglacial rock surface temperatures of 94°C along with multiple distant fumarole vents resulted in speleogenesis of a multi-level cavesystem. Two primary chambers concentrated around fumaroles were joined by a conduit passage along the rock-ice margin. Minerals associated with fumarolic activity and hydrothermal alteration historical and ongoing subglacial volcanic activity. Thermal flux and chimney effects to airflow influence distribution

patterns of diverse volcanic gases, H2S, SO2, CO2, and CO present. Cave morphology and mineralogy data support the assertion that subglacial cavities were exposed by glacial retreat rather than caused by volcanic activity.

The complete presentation you can find on: https://uis-speleo.org/index.php/proceedings-of-the-international-congress-of-speleology-ics/ look for Volume 5 Page 163-167

Lava tube discoveries in Hawai'i made by Civil Defense for the nuclear fallout shelter program (Session 01)

by: Annette S. Engel (1)

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Abstract

People have used caves for refuge and shelter throughout millennia. However, the deliberate work of United States government agencies to find and prepare lava tubes for its nuclear fallout shelter program was unmatched in history. In Hawai'i, with few buildings suitable as shelters, and with no one to speak out for the protection of significant archaeological, cultural, geological, and biological resources found in lava tubes, the Office of Civil Defense actively searched for lava tubes to add to the fallout shelter inventory. From 1961 through the mid-1970s, Civil Defense discovered and explored dozens of lava tubes. Here, based on local newspaper stories and Civil Defense literature, a timeline about the shelter program and its discovered lava tubes is presented. On Hawai'i Island, 43% of the shelter spaces, for over 50,000 people, would have been in 28 different lava tube systems. Only 4% of the shelter spaces on Maui and 14.6% on Kaua'i would have been in lava tubes. In time, the shelter program failed and shelters were not needed. However, we have the fallout shelter program to thank for finding some of the most significant lava tubes in Hawai'i, from which a legacy of exploration and scientific study would begin.

The complete report you can find on :
https://uis-speleo.org/wp-content/uploads/2025/09/19ICS_Proceedings_Vol-I.pdf
Look for page 77-81

Down the crater – a short history of vertical volcano anthropospeleology (session 01)

.by Franz Lindenmayr

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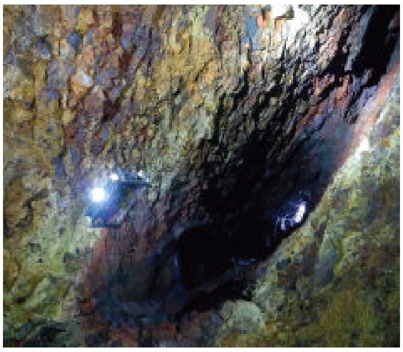
Abstract

"Tout est l'âbime." Charles Baudelaire

In only 9 examples from history and literature I want to present different human approaches to volcano craters and other abysses, concentrating mainly on the descent into them, the psychological and sociological background and the used access devices and techniques. There are a lot of other places, events and persons to be mentioned all over the world – indeed the topic is a treasure trove with no bottom in sight.

The complete report you can find on :
https://uis-speleo.org/wp-content/uploads/2025/09/19ICS_Proceedings_Vol-I.pdf
Look for page 114-116



Pyroduct Terms

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Analysis of lava caves has shown that the number of different genetic types is huge (Kempe & Smets, 2025). Albeit, by number and length pyroducts (colloquially known as "tubes")" surpass any of the other classes. The term “pyroduct” was coined by observing active lava conduits on Mana Loa, Hawaiʻi in the first half of the 19th century (Coan, 1844; Kempe, 2002; Lockwood & Hazlett, 2010; Lockwood et al., 2022). The term “tube” is purely morphological and ambiguous (Halliday, 2002) and should be avoided. Here is a set of terms used recently in discussing the details of pyroduct genetic processes, evolution and morphology for further discussion and usage and spelling of Hawaiian words.

ʻAʻā:

Blocky lava, irregular chunks of lava (cinder), loose (clasts) or partly welded together, forming the upper and bottom layers of an ʻaʻā flow, bracketing a solid core layer often many meters thick (blue rock). Cases are known of ʻaʻā flows without a bottom sheet of cinder.

Bottom sheet:

As the lava flows across the ground, some of the lava freezes, forming a sheet of solid lava, if the conduit is not drained quickly but active for weeks or even months, the sheet is removed by downward erosion, and eventually replaced by the final sheet, only a few centimeters thick.

Benches and shelves:

Horizontal benches are often found in pyroducts. They may be accretionary, composed of vertical linings grading laterally into protruding shelves that may close to form secondary ceilings. However, benches can also mark solid pāhoehoe sheets or the cores of an ʻaʻā flow, that were cut through by downward erosion and stand out because of their compact texture.

Conduits, initial:

In a pāhoehoe lava flow, probably depending on the evenness of the terrain, lava spreads finger-like with small initial conduits. These are one after the other cut-off from the flow and partly drained. Since they are small and have drained before cutting down, they mostly have a flat and glassy floor and can be tubular in morphology.

Contraction cracks:

The sheets of the primary roof contract while cooling and forms cracks, dissecting the layer or layers into angular slabs, sometimes hexagonal. This can cause breakdown of the roof layers or the entire roof during cooling. Contraction cracks occur also in the bottom layer of pyroducts. Their depth indicates if there was ponded or pooled lava below or if the layer is the thin bottom layer indicative of the downward erosion of the conduit.

Erosion:

Evidence shows that lava flowing contained in pyroducts can erode substantially into underlaying older pāhoehoe, ʻaʻā, ash-layers, soils or other rocks. The exact process remains unclear, several possibilities exist: partial melting, mechanical scouring, hammering (below lava falls), collapse by undermining, small phreatic explosions. Ash-layers and ʻaʻā -rubble are the easiest to erode mechanically, they are also prone to contain water that can be heated explosively. Upward enlargement of the pyroduct is also important, as roof collapses during activity can enlarge the cave rapidly.

Glazing:

Glazing is the glassy inner surfaces of pyroducts, evidence of remelting by intense heat. This melt can produce “runners” and drip-features.

Haematization:

If oxygen-rich air enters a hot pyroduct, it can oxidize the Fe^{2+} in the glassy surface to Fe^{3+}, forming small hematite crystals (Fe_2O_3), that redden the upper millimeter of still hot lava. The reddening can also affect the surfaces of cut-into ash or ʻaʻā clinker beds.

High level mazes:

Many lava caves, especially those of the continental USA seem to be "mono-trunked", i.e. on the map they look like winding worms. In the caves of Hawaiʻi, however, there are, in addition to the trunk passage, maze-like passages present. Characteristically these passages are small with smooth floors and are found leading off the main passage near its primary roof. They seem to be remnants of the initial conduit system. As soon as one of the conduits is eroding down, it cuts the lava supply of the other conduits or drains them one by one.

Honeycombing:

Intense heat can cause the hot interior of ceiling sections encircled by contraction cracks to melt. The walls of cracks, cooler than the interior of the slab's interior, stay behind as ridges, thus the ceiling resembles a large "honeycomb". This has been noticed in caves on Galapagos, Jeju and Hawaiʻi. The run-out interior may be preserved on the floor or on ledges below forming roundish blobs of lava.

Inflation:

Inflation, observed in the distal parts of most pāhoehoe flows, occurs as advancing lava solidifies, reaching a temporary standstill. The solidified lava is uplifted as liquid lava within continues to accumulate beneath the surface crust, heaving it upward and fracturing it in places. Slabs of ropy lava at the cooling flow margin may be steeply tilted or even overturned. Inflation is a significant process associated with the overall development of most large pyroducts world-wide. Exsolving gases concentrating beneath and within the solidified layer of surface crust can also contribute to lifting it.

Lava channel:

The channel of a lava river confined within accreted levees in a spreading lava flow. It has an incandescent, mobile surface while active and may develop an upslope -growing roof accreting upslope by several processes, thus transforming into a pyroduct.

Lava falls:

Lava falls are one of the most evident features of erosion within pyroducts. They can be as high as 10 m. They erode downward and backward, leaving size-able pool-rooms and canyons below.

Lava flow:

A body of lava resulting from an individual volcanic eruption. If it lasts sufficiently long, a low viscosity lava flow generally forms a pyroduct oriented in the general direction of movement which helps transport fresh lava with minimal heat loss from the vent to the advancing flow front downslope.

Lava intrusion:

Younger lava flows may pour into the pukas (or skylights) of older underlying products or break through their roofs, to flow inside them as lava intrusions. Most lava intrusions are short; a few tens of meters and consist of lava appearing in sharp contrast to the enclosing older pyroduct floors and walls. One spectacular example of a lava intrusion occurred in the upper end of Keʻala Cave, Puna, Hawaiʻi. There, intruding, younger, ropy lava flowed about 190 m down the older Keʻala passage before stopping, terminating in glassy pāhoehoe toes.

Lava rolls:

Lava quickly invading a still hot passage may fill it to a certain level. As the lava progresses downhill, its level sinks, but the several cm-thick lining left on the wall, cooled but not yet solid, can peel-off the wall and roll inward, producing spectacular "rollers".

Lining:

Vertically stratified lava laminae of pyroducts along walls. It forms a secondary tapestry over older rocks down-cut into. Its surface is normally glazed. Multiple layers may be evidence of lava backing up when the conduit is temporarily obstructed.

Makai, mauka:
Hawaiian words respectively for "downhill" and "uphill", are often used in the description of caves in Hawaiʻi as a short-hand term. If it should be used internationally, is up to everybody's choice.

Pāhoehoe:
Hawaiian for lava with a smooth, ropy or shelly surface. If inserted underneath a surface layer by inflation, it is bordered by shear planes and forms regular sheets.

Primary roof:
The roof of a pyroduct can consist of one or more sheets of lava. In case of an inflationary roof, the interfaces are devoid of ropy surfaces and often diminish in thickness downward (inverted stratigraphy). Often residual melt "bleeds" from interfaces. The inflationary stack may be covered by a succession of ropy lava sheets that may derive from a later eruption or a breakout of the same eruption from uphill. If the roof is formed across a lava channel, the sheets of the closing shelves are either thin-layered and close at a suture, or they are composed of welded clasts reinforced by "squeeze balls".

Puka:
A Hawaiian word for a hole or cavity. It is used to summarize "skylights" (small roof window overhanging on all sides) and "collapse holes" (large roof collapses forming circular or elongated interruptions of lava caves, corresponding to "sinkholes" or "collapse dolines" in carbonate terrains).

Puka, cold:
When the primary roof collapses, a skylight or puka or trench is created. If this happens after cessation of activity, the volume of the collapsed material at the floor is equal to the volume of the collapsed roof section.

Puka, hot:
When the primary ceiling collapses during activity, all or most of the material has been carried away by the flowing lava underneath. Hot pukas serve as vents for hot gas. If there are two or more pukas, the one at the highest position will serve as gas escape, while at the lower one, cold air is sucked in. This leads to a cooling of the lava flow underneath freezing out a secondary ceiling, in Keʻala Cave, Hawaiʻi, it is longer than a kilometer.

Pyroduct:
A post-eruptional conduit for molten lava formed inside a lava flow as it spreads downslope. The lava inside flows by gravity in contact either with the ceiling or with a gas space above. If flowing in contact with the primary roof, its pressure cannot exceed the pressure exerted by the weight of the roof, otherwise lava would break-out to the surface forming a root-less vent. Lava flowing inside a pyroduct may erode and enlarge the conduit downward, sideward and, by partial roof collapses, upward. Therefore, most long-lived pyroducts are already gas-filled cavities even if the lava would not drain after the eruption stops. To distinguish caves with pyroduct origin from other types of lava caves (e.g. resulting from river erosion), various morphological features should be present such as downslope directed flow lobes on the floor.

Secondary ceiling (septum, internal roof):
With the deepening of the pyroduct, the gas space above can cool, and internal ceilings can freeze, separating the cavity in two (or more) levels. These internal ceilings occur often below hot pukas or in deep canyons. Most of them close by thin shelves "zipping" together at the downstream end. Ceilings composed of welded clasts are also known. The up-stream end of the ceiling is often closed, because floating lava balls may be scrapped off the lava river, stranded in the upper level and welded by spatter, so that the entrance to the upper passage above the ceiling is hidden. In Puna, Hawaiʻi a secondary ceiling has proven to be over a kilometer long. Its upper passage was considered a separate pyroduct until surveying and exploration showed it to be the upper level of Keʻala Cave.

Squeeze balls:

Ball-like injections into interspaces of floating clasts or into strata of loose ‘a‘ā clinker cut into by downward erosion.

Superimposed pyroducts:

In Hawai‘i we have a few cave systems with passages overlaying and crossing each other. They seem to be linked to voluminous eruptions when such an amount of lava is available, that several flows evolve on top of each other. Lava apparently can then connect between the various levels. These pyroducts are not well understood yet.

Valve:

When travelling along pyroduct passages, the size of cross-sections can vary easily by a factor of ten, i.e. large, hall-like passages change with small ones, often necessitating stooping or crawling. Thus, the smallest cross-section acts as a valve of lava flow rate which cannot increase down-hill arbitrarily and larger passages cannot be filled again. Lava may back up above the valve, until it either breaks out to the surface or enlarges the valve by erosion or removing collapses. In consequence, long pyroducts probably are regulated to have the same flow-rate throughout.

Venting:

As the lava flowing in a pyroduct cuts into the subsurface, a gas-space is created above it. If the roof collapses to open pukas, hot gas and heated air will start streaming between them. Hot gas venting from the upper puka will draw cold air into lower pukas, and a secondary ceiling can freeze out below. For example, most of the hot pukas in Kazumura Cave have secondary ceilings underneath.

Acknowledgement:

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Stephan Kempe at the "kleine Jettenhöhle (Harz), August 2025, Picture: Firouz Vladi.

A visit to some Icelandic caves

Pictures from a visit in January 2026, by R. Prévot

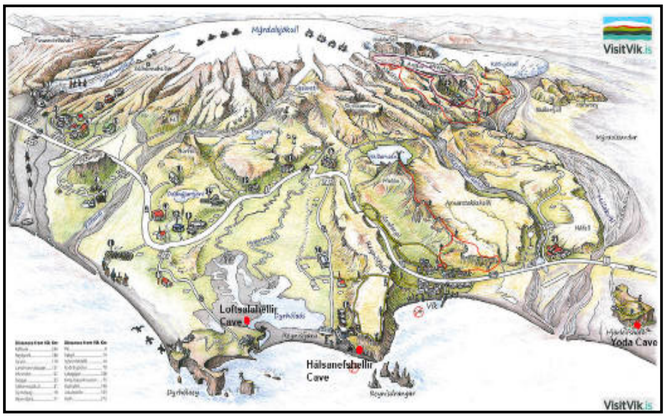

fig 1: reference vikcamping.is

From the editor:

In January 2026, a member of Speleo Nederland visited Iceland.

Through his stunning photographs, I hope to offer you a brief glimpse of this remarkable island and its volcanic caves.

Hálsanefshellir Cave this year, located at the famous black sand beach of Reynisfjara in Iceland (fig 1) . It seems he was fortunate, as only a few weeks later the beach got closed to the public due to severe erosion—an event rarely seen at such a scale. Much of the black sand beach disappeared, some rocks fell from the cliffs, and it became clear that the area was too dangerous for tourist visits.

Hálsanefshellir Cave (fig 2) is well known as one of the filming locations for the TV series Game of Thrones, where it appeared as the "Dragonglass Cave." The cave is part of the Katla UNESCO Global Geopark and is situated beside striking basalt column formations. The main chamber inside measures approximately 27 by 20 meters.

Note from Árni B. Stefánsson : .

The cave in Reynisfjall is a „pure" littoral sea cave. Formed in basaltic rock by the erosive powers of the North Atlantic.

fig.2 : Looking out of Hálsanefshellir Cave , a by sea and wind eroded volcanic cave. Picture: R. Prévot

The second cave the cavers visited is called **Gígjagjá** (Icelandic for "Yoda Cave"). This lava cave is located in the 221-meter-high island mountain.. The cave was used as a filming location for Star Wars. When you look from inside the chamber toward the entrance, you can see the silhouette of Yoda framed against the ocean. The chamber measures approximately 20 by 15 meters. It is definitely worth a visit if you are in the area. For info: Yoda is the fictional character from the Star Wars universe. View Fig 3 and 4.

Note from Árni B. Stefánsson : .

The cave in Hjörleifshöfði is a former sea cave, formed when the sea level was at the same heigth, or a bit higher than the entrance. Since its formation wind and freezing have eroded the inside a bit. Hjörleifshöfði is composed of basaltic tuff, (geol. tindur., Icel. móberg) produced by the explosive activity of a subglacial or „submarine" volcanic eruptions. The rock is rather soft cinder conglomerate fused together by rust and heat, and erodes often „easily". The Westmann Islands are a prime example. Móbergshryggir (tuff ridges,geol) are are formed by subglacial fissure eruptions. Stapi (Icel), geol. name tuya, arise in an eruption from a single vent (tindar) formed underneath a glacier, or below sea level. Tindar and tuyas, distributed all over the present volcanic zone, are remnants of the last glacial period. The shoulders of the tuyas are at the same heigth as the thicknes od the ice sheet at the time of the eruption.

Fig 3: Gígjagjá or "Yoda Cave". Picture: R. Prévot

Fig 4: Looking outwards Gígjagjá or "Yoda Cave". Picture: R. Prévot

The **Loftsalahellir** cave (fig. 5) is located on the southwestern side of Geitafjall. It is unique because it is formed from tuff stone covered with moss. Tuff is also of volcanic origin but consists mainly of volcanic ash, which makes it softer and more porous.

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Compared to other caves in Iceland, such as Raufarhólshellir, Loftsalahellir is relatively small. The cave played an important role for the residents of the village Vík í Mýrdal. In the past, Loftsalahellir was generally used as a gathering place for farmers.

Note from Árni B. Stefánsson :

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Loftsalahellir is an erosion cave in basaltic tuff/ conglomerate (Icel móberg). It probably started forming when the sea level was at the same height as the entrance, shortly after the last ice age. Since it´s formation, wind and freezing have done their job. The erosive material/rock/sand has found its way down the scree below. It might also be a pure wind/freezing erosion cave.

Fig 5: The outcrop of Loftsalahellir cave . Picture: R. Prévot

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Proposed Management Plan for Cueva del Tigre (Malargüe, Mendoza)

Gabriel Moya & Carlos Benedetto
Images edited by Julieta Garcia
(Edited with AI-assisted tools)

General description and contex

Cueva del Tigre is a volcanic-origin cave located on a basaltic plateau southeast of Malargüe, Mendoza, near Laguna de Llancanelo. It is a lava tube formed in Pleistocene basalts, officially registered under code M-12 in the Argentine Speleological Cadastre (CEA). The cave is on private property (Establecimiento El Palauco – Dr. Sergio Rostagno), so its use and access depend on the owner's authorization (fig. 1).

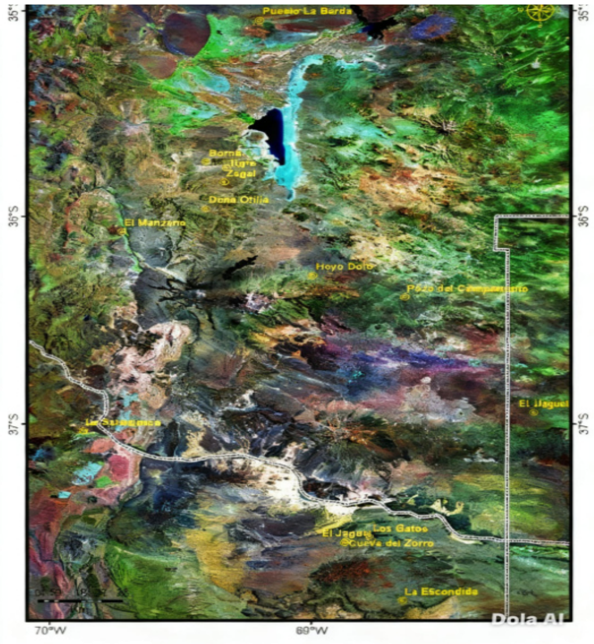

Fig. 1 showing the map of the caves discovered in the area 20 years ago

With a development of approximately 263 meters and a vertical relief of about 8 m, the cave has a sinkhole/collapse-type entrance (fig 2 and 3) on flat terrain. Entry is through a floor shaft with a free drop of around 4 m. A fixed METAL ladder was historically installed but was removed in 2001 to discourage uncontrolled visits. From the descent point, the cave splits into two main galleries (north and south). The south branch splits near the end and includes several collapses, while most of the cave is easy to traverse over loose sandy floor. The lack of internal watercourses and the presence of collapses suggest a fossil, low-energy environment (little natural dynamism).

Fig. 2: Access mouth. Photo from the surface

Fig.3: The same mouth seen from inside the cavity.

The speleological history of Cueva del Tigre includes explorations since the 1970s. A survey fig. 4) was produced by the Centro Argentino de Espeleología (CAE) in 1973, and a more detailed map was made by the Instituto Argentino de Investigaciones Espeleológicas (IN.A.E.) in 1996. In February 1997, during the FEALC Speleology Congress held in Malargüe, the cave was visited and sampled by an international team for scientific study, highlighting its importance in the regional context of La Payunia and confirming its unique natural value.

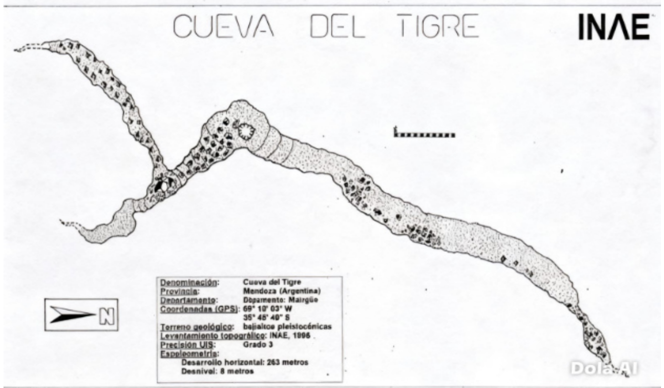

Fig. 4: Survey of Cueva del Tigre

Scientific importance: geology, mineralogy, and microclimate .

Cueva del Tigre is of notable geological and mineralogical interest. As a lava tube in an arid climate, it has developed singular chemical deposits. Parts of the walls and fallen lava blocks are coated with white efflorescence's in the form of fibers and translucent crystals. Mineralogical analyses identified highly soluble evaporite minerals, particularly sylvite (KCl), thenardite (Na_2SO_4), blödite ($Na_2Mg(SO_4)_2 \cdot 4H_2O$), and kieserite ($MgSO_4 \cdot H_2O$). These minerals form and are preserved thanks to an extremely dry cave microclimate. Their genesis is attributed to evaporation of saline solutions under very low humidity, possibly with contributions from external aerosols and compounds derived from animal guano. The joint presence of halides and hydrated sulfates is typical of arid, well-ventilated cave environments, as noted by Urbani (1996, 2009).

The cave's internal microclimate is cold and dry. Average temperature is around 10 °C and is relatively stable. Relative humidity has not been measured, but the presence of gypsum and salt efflorescence's suggests it is very low. This balance is fragile: increased humidity could hydrate or dissolve salt crystals, irreversibly altering these formations. For example, thenardite can transform into mirabilite when absorbing water. Such salts act as sensitive indicators ("canaries in the mine") of even small changes in humidity or CO_2. Preserving the natural circulation of dry air is a priority, and any management must avoid introducing excess moisture (e.g., through many visitors' breathing, sweat, or wet gear) or obstructing natural ventilation.

Beyond mineralogy, the cave offers a unique setting for volcanology (lava-tube origin) and paleoclimate studies. The cave salts can serve as chemical records of regional aridity, and preserving them enables future comparative research with other volcanic caves worldwide. Overall, Cueva del Tigre is a natural laboratory combining volcanic geology and uncommon secondary mineralogy, justifying strong scientific protection.

Cave biota: fauna and ecological considerations

Although Cueva del Tigre does not host strictly endemic troglobitic fauna (species adapted only to subterranean life), it plays an important role as a refuge for surface fauna. Insectivorous bats use the cave as a roost and potentially as a hibernaculum. Speleobiological studies (PCMA Mendoza, 2008–2012) recorded at least three species in caves of the area, including Myotis levis, Tadarida brasiliensis, and a Histiotus sp. (an "big-eared" bat). These bats feed on insects and rely on caves to avoid extreme desert temperatures and predators. They may enter daily torpor to save energy, requiring stable temperature and humidity conditions and isolation—conditions that caves provide. In arid and mountainous ecosystems of Mendoza, caves are often the only natural refuges with such micro-climatic stability, so protecting the cave also protects these species and their ecological roles (insect control, pollination, etc.).

Along with bats, the steady deposition of guano supports a small invertebrate community. Surveys reported Tineidae moths (pupal cases in guano and adults throughout the cave) and flies (dipteran puparia) associated with decomposing organic matter. Pholcidae spiders have also been observed near the entrance twilight zone, preying on insects attracted by guano. These organisms form a trogloxene assemblage—species not exclusive to caves but that use the subterranean environment for feeding or shelter.

The cave has also recorded occasional incursions of larger surface fauna, evidenced by bones, droppings, or tracks. Studies in 1991 reported signs of mammals such as viscachas (Lagidium sp.), armadillos (Tolypeutes matacus), a juvenile puma (Puma concolor), the Patagonian weasel (Lyncodon patagonicus), and even goats that may have fallen in or entered seeking shelter. This suggests the entrance can sometimes act as a natural trap or temporary den. While these are not resident populations, they underscore the need for caution (e.g., there may occasionally be fallen animals or decomposition inside). .

In summary, biologically Cueva del Tigre functions as an important underground refuge for surface species. Conserving its conditions directly benefits local bats, whose habitat needs are increasingly constrained outside. Any management plan should therefore protect cave fauna, avoiding disturbances that could drive bats away or interrupt the guano-based food web.

Fragility of the subterranean environment and threats

Despite its rugged appearance, Cueva del Tigre is a highly fragile and non-renewable environment. In low-energy caves (no significant water flow and limited air exchange), human impacts accumulate and do not reverse on human time scales. International IUCN guidance notes that in such systems regenerative capacity is essentially nil, and even minimal visitation can cause irreversible, cumulative impacts. Damage such as breaking mineral deposits, soil compaction, or disturbing fauna will not naturally "heal" in a meaningful timeframe, which is why a precautionary approach is essential.

Main threats identified: .

Microclimatic alteration: Uncontrolled visitation can change temperature, humidity, and air composition (e.g., increased CO_2). Because the salts require dryness, excess moisture from many visitors, sweat, or wet equipment could dissolve or alter them, reducing scientific value. Changes in temperature or light can also displace bats from preferred roosts.

Direct impacts from unregulated tourism: In the past, before a plan existed, the cave was visited irregularly without permits or proper equipment. This caused dirtiness (trash and guano spread along the route), deterioration of features, and risks to visitors. Reports mention poorly equipped student groups without helmets and trash left inside. Lack of supervision also enabled unsafe acts such as lighting fires or collecting mineral "souvenirs," according to informal testimony. Such uncontrolled use seriously compromised the site's integrity.

Unrestricted accessibility: Before 2001, a fixed ladder at the entrance allowed easy access. Combined with proximity to roads (about 40 km from Malargüe and near Provincial Route 186, with vehicle tracks reaching close to the site), this encouraged spontaneous visits. In December 2001 the IN.A.E., with the owner's agreement, removed the ladder. Since then, entry requires specialized equipment (portable ladders or ropes) and knowledge of the exact location, greatly reducing clandestine incursions.

Lack of specific legal protection: Unlike nearby Caverna de Las Brujas (a provincial protected area), Cueva del Tigre is not inside an officially declared park or reserve. As private property, protection depends on the owner's commitment plus technical support from speleological bodies. Potentially harmful surface activities (drilling, construction, overgrazing, etc.) could indirectly affect the cave (infiltration changes, vibrations, contamination). Mendoza's protected areas framework can be applied on private land through agreements or voluntary conservation easements, so it is recommended to pursue conservation agreements with the owner so authorities can formally recognize and support protection.

Overall, the main threats come from inappropriate human use. Without management, the cave deteriorated incrementally. Initial corrective actions—especially restricting physical access—have helped. The strategies below aim to ensure long-term conservation while allowing educational, safe, and sustainable tourism use at low levels.

Proposed management and conservation guidelines .

Following international best practices for cave and karst protection and recommendations from national speleological organizations—prioritizing those legally based in Malargüe (FAdE)—this document proposes an integrated management plan for Cueva del Tigre. The main guidelines are as follows:

Restricted and controlled access: Entry will be limited exclusively to guided visits authorized by the owner. The Payunia Agency (tour operator) will coordinate excursions with explicit owner permission to ensure there are no spontaneous entries. There will be no external signage on the property; the cave mouth will have no visible signs to avoid attracting unauthorized visitors. Only authorized guides will locate the entrance. If needed, a discreet perimeter closure or hidden lock may be implemented (e.g., a grate or camouflaged cover at the mouth) without altering natural ventilation. Any closure must preserve natural airflow, which is critical for conserving the cave environment.

Minimal, removable infrastructure: No permanent tourist infrastructure will be built inside the cave. Descent will be via portable ladder or rope, installed by guides at the start of each visit and removed at the end to maintain access difficulty when unsupervised (continuing the deterrent policy begun with ladder removal in 2001). No boardwalks, fixed lighting, or paved trails will be installed. If necessary, only small, discreet route markers (e.g., reflectors or low stakes) may be used to guide visitors away from sensitive areas, using inert materials and avoiding adhesives or chemicals.

Carrying capacity and visit duration: A strict low-number policy will be adopted. Each group will have a maximum of 10 people. Only one group will be inside the cave at a time, with at least 45 minutes between a group exiting and the next entering. This recovery time helps the cave return toward baseline conditions (CO_2 dissipation, temperature/humidity re-balancing). These values can be adjusted based on monitoring, but are conservative starting measures consistent with fragile cave management: "less is more."

Strict behavior rules: Before each visit, the guide will brief visitors on cave rules. Visitors must stay on the indicated route and avoid dispersing. Touching walls, ceilings, mineral formations, or removing anything is prohibited. Salt and gypsum deposits are extremely delicate; even skin oils can dissolve them. Gloves will be used if any support is needed, and guides will indicate safe contact points (rocks without visible minerals). Collecting "souvenirs" is strictly forbidden; the cave is natural heritage and every element is part of its ecosystem. Smoking, eating, and leaving waste are prohibited. If water must be consumed, it will be in designated areas and all containers will be carried out ("what goes in, comes out"). Guides will carry bags to remove any litter found, contributing to restoration from past impacts.

Equipment and safety:

All participants must have a helmet with headlamp, trekking footwear, and clothing appropriate for ~10 °C and dust. Masks or scarves over nose and mouth are recommended due to fine dust and dry guano particles. Each group will have at least two qualified leaders (a lead guide and a rear assistant). Guides will carry basic emergency equipment (first-aid kit, spare light, auxiliary rope, and a portable CO_2 meter). Entry and exit times and group size will be logged, and an external contact will be notified as a safety protocol. Because access involves a vertical descent, a secure anchoring system (removable anchors on stable rock) will be used for rope/ladder, following speleology safety standards. Guides will assess collapse stability and mark any unsafe areas. Visitor accident insurance and clear evacuation procedures will be in place.

Protection of cave fauna:

Visits will be planned to minimize disturbance to bats and other fauna. Whenever possible, tours will avoid sensitive periods (winter hibernation and breeding season if pups are detected). If PCMA determines specific vulnerability windows, those dates will be excluded. During tours, guides will avoid shining lights directly on bat clusters and will keep noise low. Observations of fauna (approximate bat numbers, behavior, new remains) will be recorded to support biological monitoring. If large dead animals are found, specialists will be notified before removal, as the material may be of scientific interest.

Ongoing environmental monitoring:

A practical monitoring program will assess tourism impacts and enable adaptive management. Before regular visits begin, baseline measurements will be established (temperature at several points, relative humidity, CO_2, and reference photos of salt crusts). During operations, guides will measure CO_2 and temperature at entry and exit with portable meters and record significant changes. If thresholds are exceeded (e.g., CO_2 increases well above baseline or humidity rises notably), group size and duration may be reduced and recovery time increased. Semiannually, reference photos will be compared to detect changes (loss of shine, mineral alteration, fungal growth, etc.). Specialists (geologists, biologists) from FADE, universities, IADIZA–CONICET, or PCMA will be invited periodically for technical inspections. If any deterioration is detected, corrective measures will be triggered immediately, including possible temporary closure.

Waste management and cleaning:

The cave must remain as clean as—or cleaner than—it was found. All waste generated or found will be removed. Sealed containers will be placed outside at the meeting point for collected litter, which will then be taken away. Periodic volunteer cleaning days (e.g., annually) can remove historical trash. Existing graffiti will be documented and evaluated for removal using non-invasive methods (gentle mechanical cleaning, no chemicals). Guano will not be "cleaned" because it is part of the ecosystem, but visitor movement will minimize dispersal. If needed for visibility or respiratory comfort, limited dust-suppression measures could be considered only under expert advice and without affecting minerals. Any item introduced into the cave must be removed (e.g., used batteries).

Environmental education and interpretation: Each visit will be an opportunity for education and awareness. Guides will explain lava-tube geology, point out (without touching) salt formations and their fragility, and highlight the ecological value of bats. The goal is to turn the experience into a 'cave-classroom' and promote a citizen-science mindset (e.g., noting observations). At the end, visitors will reflect on what was learned and be encouraged to act as ambassadors for conservation. Informational materials (digital brochures, panels at the agency) will highlight relevant scientific work and the fact that international specialists have studied the cave for its unique mineralogy and biology, reinforcing the conservation message.

Coordination with institutions and plan updates: Implementation will involve key partners. FAdE and related groups, firefighters, and gendarmerie units trained in speleology and cave rescue will be invited to support planning and guide training. Contact will also be maintained with Mendoza's Directorate of Protected Areas, the relevant authority for natural cavities under provincial law. This document is dynamic: it will be reviewed and updated periodically (e.g., every 2 years) or as new evidence requires. Visitor feedback and reports from guides and scientists will be collected, and an annual cave-condition assessment will be conducted. Effective cave management requires an interdisciplinary approach and cooperation between owners, guides, scientists, and authorities; major decisions will prioritize preservation over short-term profit. It is also of interest to investigate whether the cave originated from effusive eruptions of the "Cerro Fiero" volcano (fig. 5) on the same property; if confirmed, the cave's speleometric understanding could change substantially.

Fig. 5: View on the Cerro Fiero Volcano

Responsible and sustainable tourism use:

Under this plan, Cueva del Tigre will be positioned as a destination for responsible speleological tourism, adding value both to conservation and local development. By strictly controlling access and educating visitors, the operating agency can offer a unique adventure-and-learning experience. Unlike mass tourist caves with boardwalks and fixed lights, the visit here will be an authentic tour of a largely untouched cave, but conducted safely and with minimal impact. This exclusivity—small groups only, an expert guide, and a pristine environment—is itself an attraction aligned with global trends in low-volume, high-quality adventure ecotourism.

Economically and socially, the low-impact, limited-capacity model allows a price that reflects the experience's value, generating income that can be reinvested in protection and local benefits (jobs for guides, services in Malargüe, etc.). At the same time, it avoids the saturation that would degrade the cave: it chooses fewer visitors with greater care rather than mass tourism. This approach aligns with IUCN recommendations to prioritize high-value karst sites while applying strict sustainability criteria.

Regarding promotion, there will be no mass advertising for Cueva del Tigre. Marketing will be targeted to specific audiences (scientific tourism, educational groups, sport cavers) through specialized channels. Potential clients will be informed of requirements and rules, filtering out unsuitable visitors. Messaging will emphasize the privilege of visiting a hidden site under strict conservation rules—for example, "Hidden wonder in Malargüe—discover it responsibly!" This exclusivity can add value and usually increases compliance when visitors understand the reasons behind restrictions.

The experience gained here can serve as a model for other caves on private land. Argentina still lacks a specific national cave framework, so voluntary management in cooperation between private owners and the speleological community is pioneering. Demonstrating that a private cave can be conserved and used sustainably would set a positive precedent. In the medium term, if results are successful (intact conditions, fauna present, satisfied visitors, no incidents), integration into broader projects—such as a Mendoza speleotourism route—could be explored, always respecting the owner's rights.

In conclusion, this plan balances conservation with limited public use. The proposed measures—strict access control, small groups with recovery intervals, visitor education, and continuous monitoring—draw on international guidelines (e.g., IUCN Guidelines for Cave and Karst Protection) and the local experience of FAdE and IN.A.E. in Mendoza. Cueva del Tigre, once exposed to uncontrolled visitation, can become an example of good speleotourism practice. With the shared commitment of the owner, the operating agency, and the scientific community, this singular cave can continue to reveal its geological and biological features to future generations without losing its pristine character. The "Tiger" of Malargüe will keep "roaring" silently underground—protected and appreciated through responsible management.

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Report on the Volcano speleological Expedition to Armenia 2025

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Introduction

From September 16 to 23, six members of Speleo Nederland undertook an expedition to Armenia. Two additional participants joined the team for the entire duration of the trip: Tigran Armenyan, president and geologist of the Arm Speleo Network NGO, and Professor Samvel Shahinyan, geologist and president of the Armenian Speleological Centre (fig 1).

Fig. 1. The team in front of Verin Getashen 2

At the explicit request of the Armenian caving organisations, no exact cave locations are disclosed in this report, in order to protect the sites for environmental and archaeological conservation.

History

Armenia is part of the Caucasus, the mountain range situated between Turkey and Russia, and is characterized by both volcanic and limestone landscapes. The country is landlocked, with no coastline, and is bordered by Turkey, Georgia, Iran, and Azerbaijan. While the border with Azerbaijan remains the subject of ongoing (and occasionally armed) disputes, the remainder of the country is peaceful and safe, with a welcoming and hospitable population.

Soviet era:
The Armenian Branch of the Soviet Academy of Sciences was established in 1935, which led to the creation of the Academy of Sciences of the Armenian Soviet Socialist Republic (ArmSSR) in 1943.

Independence:
Armenia declared its independence in 1991, followed by the dissolution of the Soviet Union later that same year.

Restructuring (1992):
In 1992, the Academy of Sciences of the ArmSSR was reorganized and became the National Academy of Sciences (NAS) of the Republic of Armenia. (source AI).

In Armenia, only a limited number of caves are known, occurring in both limestone rock and volcanic formations. The longest caves are found in limestone areas, such as Arjeri (Bear) Cave, which is reported to exceed 3 km in length. By contrast, volcanic caves are far less common. Most are of artificial origin, and the longest known examples reach only about 150 meters.

The Armenian Highlands are part the Caucasus region. Some geologists argue that the area does not contain many extensive natural volcanic cave systems. This is remarkable, considering that Armenia alone has more than 550 volcanoes.

As one of the world's oldest countries, it is not surprising that nearly all caves in Armenia are of considerable archaeological significance.

The first reconnaissance trip to Armenia was organized in 2024 by four members of Speleo Nederland. During this expedition, 20 small volcanic caves were explored and surveyed, with a combined length of nearly 180 m. The results of this work were published in the Volcano Speleological Newsletter of the UIS, issue no. 84 (February 2025).

As a follow-up to the 2024 reconnaissance, a joint expedition was organized in 2025 as a collaboration between Armenian and Dutch cavers.

The 2024 trip provided a much clearer understanding of the geological context and the volcanic speleological potential of Armenia. Based on the reconnaissance results, the most promising areas for volcanic caves were identified, allowing specific target areas to be selected for the 2025 expedition (fig. 2).

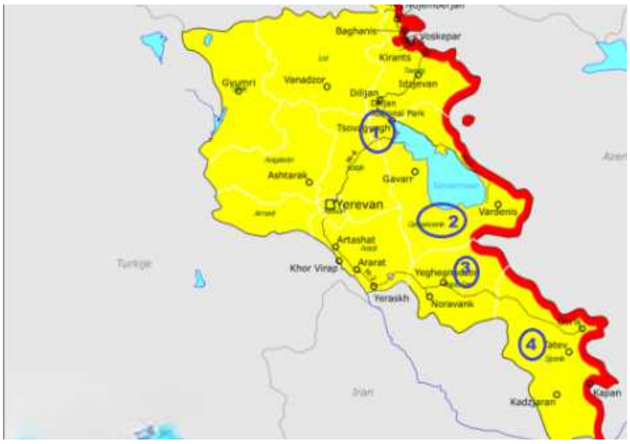


Fig 2. View on Armenia and the 4 areas which were visited, source: Natural earth/Open Streetmaps

Logistics

To maximize efficiency and flexibility, the expedition was organised around a minimal-weight approax. In addition to personal equipment, the material list included several sets of caving gear, one 20 m rope, multiple long slings, a number of carabiners, four walkies-talkies, three sets of surveying equipment, and a wide range of electronic devices for photography, route tracking, battery charging, a small compressor, and drone operations.

Eight participants travelled in two Lada Niva vehicles rented in Yerevan. All expedition equipment had to fit inside these two vehicles in addition to the team members.

Each day was carefully planned with overnight stays in lodging, so no camping was required. Breakfast and dinner supplies were purchased daily at local shops, and evening meals were usually taken at small restaurants.

The team consisted of three surveyors, one logistics and tracking manager, two photographers, and two Armenian geologists.

In total, the team drove more than 3,000 km over an eight-day period. More than 40 caves were visited, of which 37 were explored and surveyed.

The Expedition 2025

North west region of lake Sevan

The first area visited by the team was the volcanic mountain region around the city of Sevan, located at the northern end of Lake Sevan, at an altitude of approximately 2,000 m.

In preparation, numerous potential cave hotspots had been identified using Google Earth. However, after field reconnaissance, most of these sites did not reveal any accessible caves (fig. 3).

Fig. 3. Possible places of interest near Sevan, source: Google Earth.

The three caves that were explored and surveyed are all situated within the same mountain range where, in 2024, the team had already identified six lava domes, designated Surbi 1–6. The three newly discovered caves are of the same type and structural characteristics as the previously documented ones. (Fig. 4)

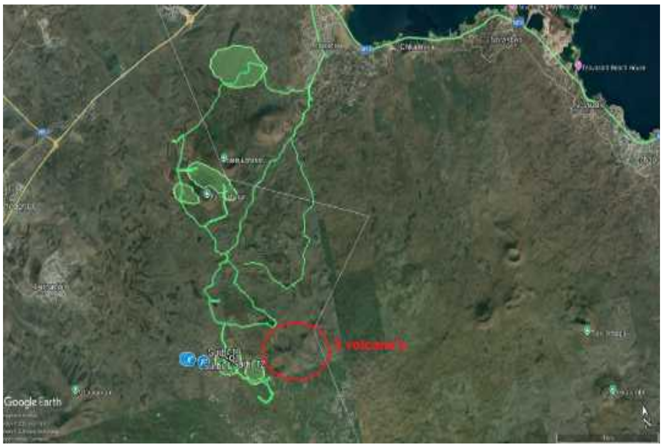


Fig. 4.Track record near Sevan. To the south, the nine lava domes all originate from three volcanic centres located to the east. Source: Google Earth.

To date, nine lava domes have been identified within the lava flows. These are likely associated with a group of adjacent volcanoes, including Mount Tsluglukh, Tsluglukh Volcano, Spisar, Yu Akor, S Akor, and Akor Volcano. These volcanic centres belong to the Gegham Volcanic Ridge, which is the natural reserve of 127 volcanic centres, lava domes, and pyroclastic cones of Pleistocene to Holocene age. The most recent known eruption in this region dates to approximately 1900 BCE.

The volcanic landscape between Lernanist and Lake Sevan is predominantly agricultural, largely covered by dense grasslands used for sheep and cattle grazing (5b).

Fig. 5b: Landscape around the Geghama lava domes

This region is characterised by a high density of lava and gas domes, situated at elevations between 2,200 m and 2,300 m a.s.l. All of these domes were formed by underground lava conduits. A thick layer of löss—deposited during the last Ice Age—covers the volcanic rocks throughout the area. Snow, frost, and substantial annual precipitation have likely sealed most of the underground lava conduits, filling them with löss sediments. This process is clearly visible in the few caves discovered by the team, where all downward openings are completely filled with sediment (fig 5d).

Fig. 5a: Entrance of Geghama 1

Fig. 5d: Sediments in a lava tube arch at lava dome Geghama 3

The cave entrances are primarily the result of collapses in the fragile roofs of the lava domes (Figs. 5a and 5c). As most of the lava domes visible in the landscape show no open entrances, it is highly likely that many additional caves remain hidden in the area, awaiting discovery.

Fig 5c: Entrance of Geghama 2.

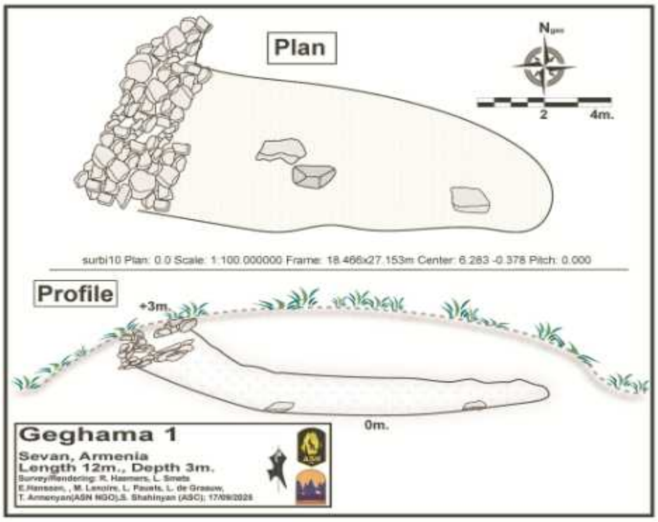
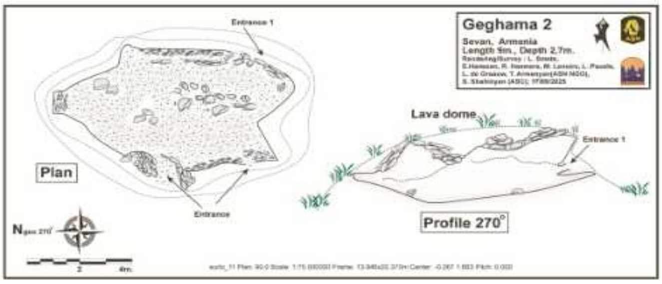
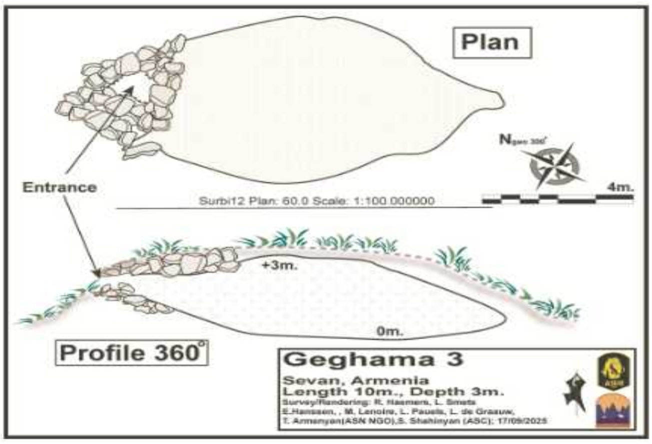


Fig. 6a: Survey of Lava dome Geghama 1



Top Fig. 6a: Survey of Geghama 2/Bottom: Geghama 3



Mart(o)uni

Southwest of the city of Martuni, a valley carved by the Argichi River. Valleys of this kind, shaped and deepened during the Ice Ages, often cut through lava flows and may expose remnants of lava conduits and other volcanic caves.

It were the Armenian cavers who had heard of a cave near the village of Verin Getashen and guided the team to this site. In one part of the village, the river forms a large bend, where marsh-like terrain has developed. In this area, several additional caves were found.

The lava flows around Verin Getashen (approximately 1,980 m a.s.l.) date from the Quaternary period. At this location, the riverbed is wide and filled with löss deposits (fig. 7a), while the upper part of the valley exposes basaltic rock walls Along these higher slopes on both sides of the valley, eroded abris and tectonically formed voids are present.

Fig. 7a: View of the Argichi River valley, with exposed lava rock at higher elevations.

The largest cave explored in this valley is **Verin Getashen 1**, with a surveyed length of nearly 80 m (fig.7b). The cave has two entrances, one of which is marked by several khachkar (religious cross-stones) located outside the entrance (fig. 8).

Fig. 8: Khachkar cross-stone at the entrance of Verin Getashen 1

Fig. 7b: Survey of Verin Getashen 1

The origin of the cave is not fully understood; however, Ice Age processes, river erosion, and tectonic activity have clearly played major roles in its formation. Evidence of an initial lava-cave genesis is suggested by sections of the roof composed of welded clasts fig. 9.

Fig. 9: Roof of welded clasts

The cave interior consists of a maze of loose blocks, unstable walls and ceilings, and a thick layer of dust covering the floor. Given the presence of khachkar stones outside the cave, as well as pottery fragments (fig 10) and bones found inside, it is very likely that the cave is of archaeological importance. The cave has two entrances which are connected through a labyrinthic crawl.

Fig. 10: Pottery in Verin Getashen 1

Verin Getashen 2 is a remarkably large lava abri located on the western side of the Argichi River fig 15). The cave lies approximately 5 m above the present river level, at the base of a high basaltic cliff. Its walls and roof consist of welded clasts of varying sizes (fig. 11). The genesis of this cave is unclear. However, given its position adjacent to the river and close to the valley floor, it is possible that an originally natural void was enlarged or modified to make it more suitable for human use or as shelter for animals. Interpretation is complicated, as many original features appear to have been altered through repeated human use, including activities such as party's and barbecues (fig. 12, 13 and 14).

Fig. 11: Welded clasts in Verin Getashen 2

Top fig 12: Entrance of Verin Getashen 2

Bottom: fig 13: View outwards Verin Getashen 2

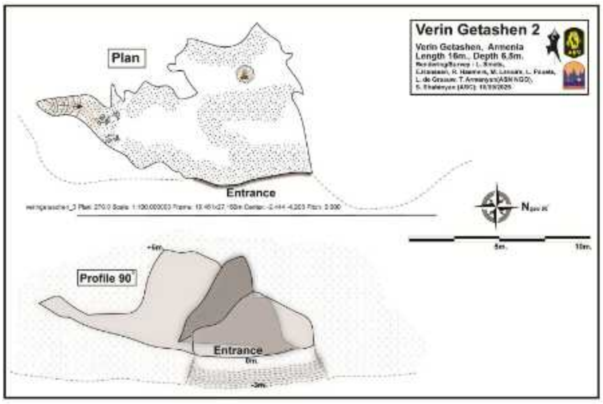


Fig. 14 Survey of Verrin Getashen 2

That same day, the team's field reconnaissance of potential sites previously identified on Google Earth led to the discovery of another cave in the Martuni riverbed, south of the village of **Geghhovit**. The cave is located on the eastern slope of the Martuni River valley at an elevation of approximately 2,215m asl., about 50 m above the riverbed.

The eastern slope of the valley consists of Pliocene basalt (approximately 2.5–5 Ma), while the western slope is of Quaternary origin (2.5 Ma to the present). The cave is a typical remnant of a small lava cave. Its precise genesis is unclear; it may have functioned as a lava conduit or may be comparable to a lava tongue cave; a cave originated at the border of a lava flow due to overlapping lava lobes and gasses (fig. 16).

Fig. 16: Rock face containing the entrance of Geghhovit 1

fig 17a and 17b: Entrance of Geghhovit 1

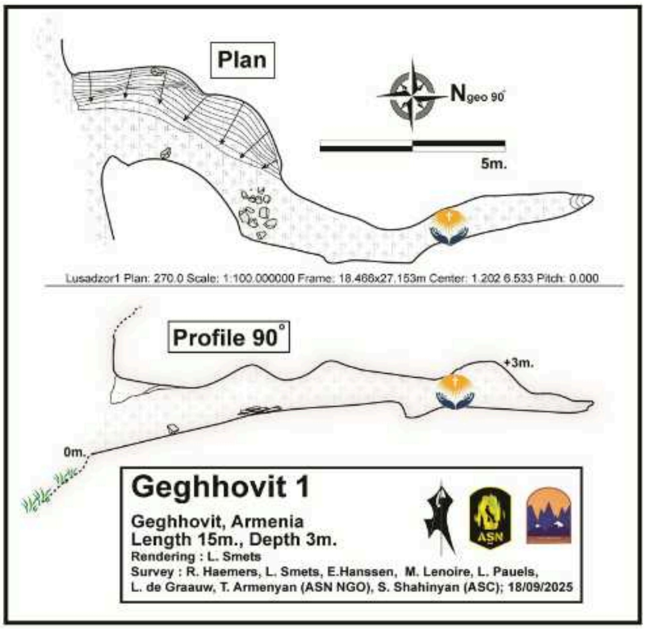


fig 18: survey of Geghhovit 1

Driving further south, the team stayed in the village of Gladzor, from where several dirt tracks lead into the Vayots Sar area. Vayots Sar is considered one of Armenia's youngest volcanoes, with its last eruption estimated at approximately 40,000 years ago (Late Pleistocene–Holocene). Historical accounts mention a catastrophic earthquake and widespread destruction in 753 AD. However, modern research indicates this may be mythical, as no volcanic eruptions have occurred in Armenia for millennia.

Mountain Vayotssar, the height of which is 2581m asl. , is located in the province of Vayots Dzor contains a crater of a depth of about 125 meters. The volcanic rock in this region consists predominantly of basalts and andesites.

In the lava tongues and on the slopes of the lava flows to the southwest of the volcano, the team discovered several caves, names **Vayots 1 to Vayots 6.**

All six caves can be classified as abris. Some likely formed as voids in between lava lobes, while others appear to result from tectonic movements and erosion along the lava slopes into the valleys.

ll of these caves have served as shelters for humans and their livestock, with some sites showing archaeological evidence and others more modern use.

Vayots 1 (fig. 20) is such an example , located under a big lavaflow lobe at the terminus of a lava flow. The altered wall shows that the cave has been used as a shelter and most likely is of archaeological importance (fig. 19).

fig 19: Entrance of Vayots 1, a void at a lava flow front

Featuring two connected entrances, Vayots 2 is located at a toe of a lava flow eroded by time and likely geologically altered during the ice age (fig. 21, 22 and 23).

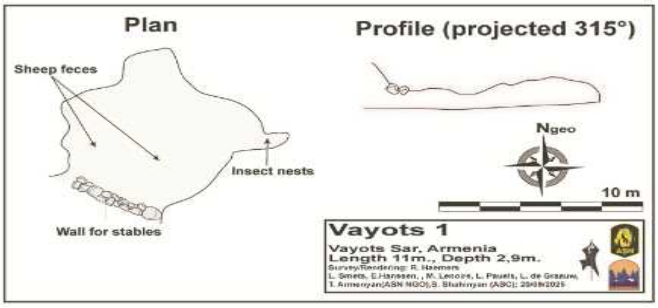


fig 20: Survey of Vayots 1

fig 21: The two entrances of Vayots 2 located in eroded lava flow terminus

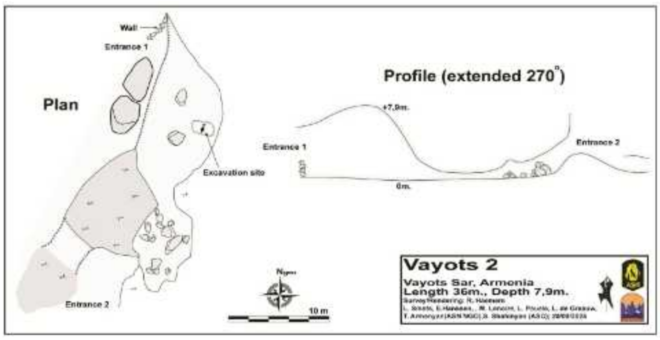


fig 23: Survey of Vayots 2

fig 22: View through Vayots 2 , roof with welded clasts

Vayots 3, 4, 5, and 6 are all categorized as the same type of lava cave. An abri-like cave with welded clast in the roof, situated at an eroded terminus of a lava flow (toe) , possible as a void in between or under multiple lava flow lobes.

Almost all of the caves contain walls composed of pyroclastic rock, breccia, a mixture of ash, pebbles, and larger melted rock fragments, often typical for lava toes or the termini of lava flows.

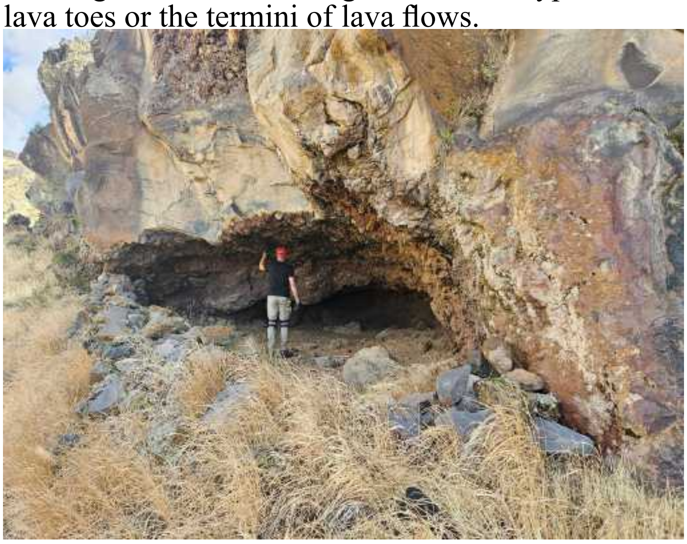


fig 24: Entrance of Vayots 3 , welded clasts in the roof

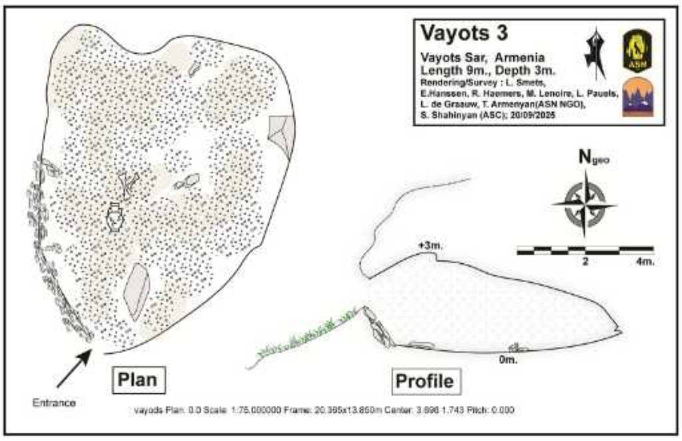


fig 25a: Survey of Vayots 3

fig 25b: Entrance of party cave Vayots 4

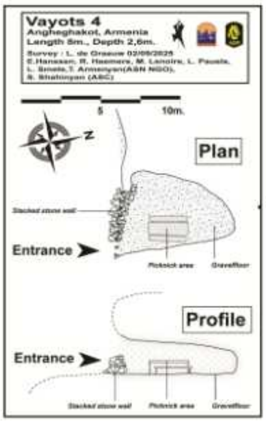


fig 25c: Survey of abri Vayots

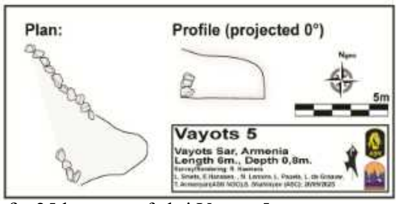


fig 25d survey of abri Vayots 5

Vayots 6 consists of a series of adjacent abris positioned along a cliff. This cliff is accessible only on foot via a narrow traverse through a cave (figs. 26–30).

fig 26: View on the traverse cave near to Vayots 6

fig 27: View on one of the abri's in the cliff near Vayots 6

fig. 28: Birdsnest near Vayots 6

fig. 29a: Abri of Vayots 6, view on typical lava toe geology

All of the Vayots caves were likely used by humans, either as shelters for themselves or for their animals. In **Vayots 6** (fig 30), an irregularly dug hole indicates that the cave has been disturbed by unauthorized archaeological activity (archeo robbers)

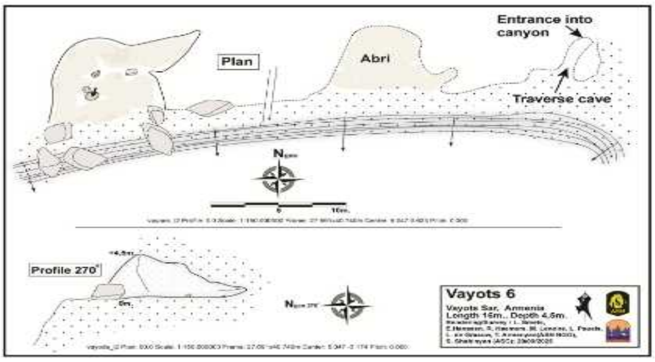


fig. 30: DSurvey of Vayots 6

fig. 29b: The entrance of Vayots 6

The eastern side of the Vayots Sar volcanic fields is considerably steeper, with lava flows halted by a late Miocene volcanic field. On this hillside, near the village of Herher, several abris and remnants of lava conduits can be found. The volcanic landscape in this area is largely covered by dense grasses used for sheep and cattle grazing. Although most of the volcanic rock is covered by a thick layer of löss, the team identified a total of nine caves in the area.

Her-her 1 and 2 are remnants of short lava conduits, likely cut through and partially filled by glacial activity during the Ice Age. Both caves are situated at approximately 1,650 m asl. and are exposed to wind and frost erosion. These caves originated as lava conduits crusted over by welded floating clasts and are located on the hillside of a heavily eroded river valley. This valley also marks the boundary/limit between late Oligocene rock deposits to the east and Middle Eocene deposits to the west.

The lava conduits were most likely opened up by erosion and rockfalls along the river valley. In later periods, the cavities probably were modified by humans and animals using them as shelters, with floors cleared and levelled. **Her-her 1** now contains a gated door (fig. 31, 32 and 33).

fig. 31: Entrance of Her-her 1

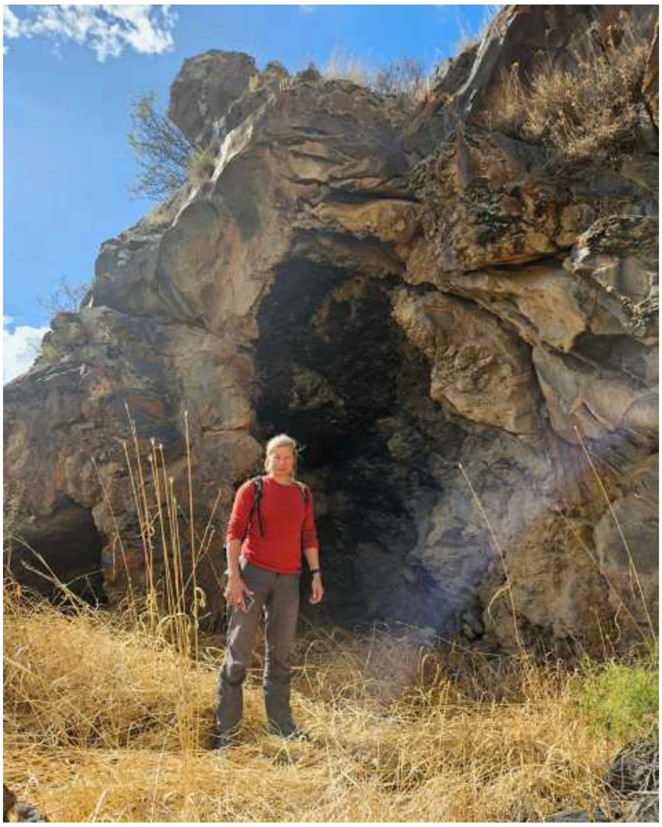


Fig. 32: Entrance of Her-her 2

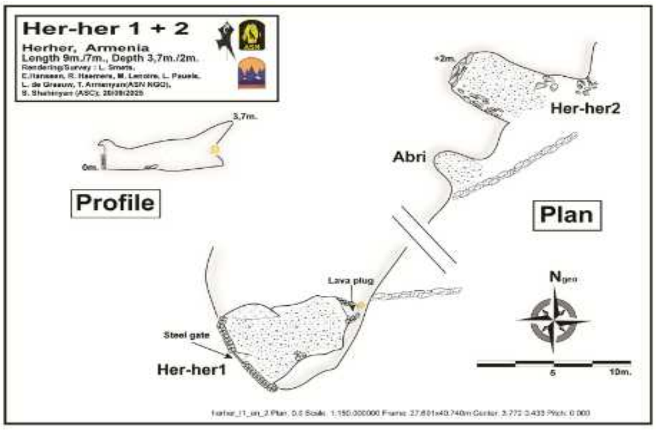


Fig. 33: Survey of Her-her 1 and Her-her 2

fig. 34a: Abri of Her-her 3 with walls of welded clasts

fig. 34b: A by erosion and/or ice friction manipulated wall at the entrance of Her-her 3

3

fig. 34c: View on the smoothed wall of Her-her 3

Her-her 3 is a small abri, notable primarily for its interesting morphological features. On the southern side of the cave, a smooth, flat wall appears as if it were cut by human activity. The cross-section of the wall reveals basaltic rock in various colours, ranging from red to black, all welded together as clasts within a single lava layer. The exact origin of this formation remains unclear.

The cave is located in the lower section of the valley on the west side of the river. It is exposed to wind, water, and ice erosion and has been modified with a man-made wall at its entrance (fig 34a, 34b and 34c). No survey was done as the cave was just 5m. long.

Herher 4 is located beneath a lava lobe resting atop another lava flow. The hillside is formed by an overflow of lava, creating multiple lava tongues, within which the cave is situated.

The entrance of the cave contains large rocks, likely fallen from the roof and the slope above. The cave originates from an older, late Oligocene lava flow coming from the northeast. The cave is located on the eastern slope of the river valley, northeast of the village of Karmrashen (fig 35a,b,c and d)

Fig. 35a: Outwards view of Her-her4

Fig. 35b: The entrance of Her-her 4 with the large collapsed rocks

Fig. 35c: View on the lava lobe wherein Her-her 4 is located

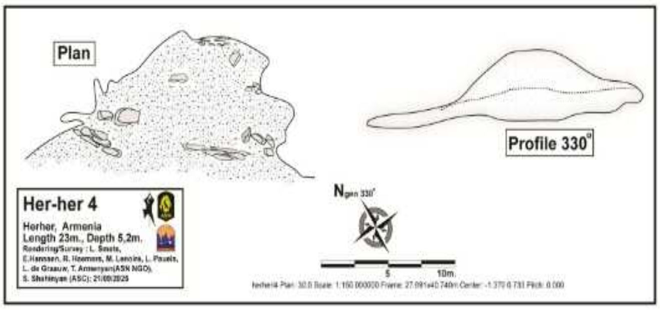


Fig. 35d: Survey of Her-her 4

Her-her 5 and 6 provide an excellent example of a lava flow formed from a crusted-over lava conduit with welded floating clasts. Walking towards these caves, a short lava bridge can be found located in the middle of the lava riverbed (fig. 36a).

Fig. 36a: View on the lava bridge towards Her-her 5 and Her-her 6. View on the lava river bed

These caves are part of a lava flow originating from an older eruption of Vayots Sar Volcano, estimated to have occurred during the Pleistocene, more than 40.000 years ago. The lava clearly descended from the slopes of Vayots Sar, carving an eroded riverbed in which several small cavities can be found.

Her-her 5 marks the point where the lava emerged at the surface, flowed through a short open channel, and then re-entered the subsurface at **Her-her 6** (fig. 36b–36c). Her-her 5 is a nice example where the lava flow eroded downwards and side-wards into the hardened lava. Although relatively small, it represents one of the most recent and exceptionally well-preserved lava cave flows in Armenia (fig. 36d–36e).

Fig. 36b: The entrance and lava bed of Her-her 5

Fig 36c: View from Her-her 5 towards Her-her 6 in the far end

Fig. 36d: Erosional view inside Her-her 5. The roof consisting of welded clasts

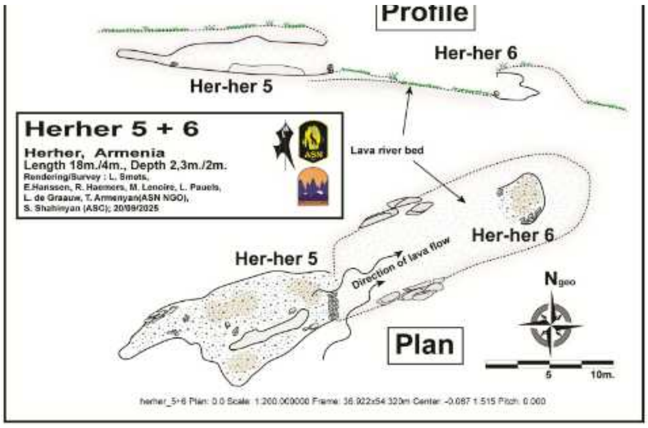


Fig. 36e: Survey of Her-her 5 and Her-her 6

Her-her 7 is a cave located in the middle of the lava flows descending the eastern flank of Vayots Sar Volcano (fig. 37a). The cave is a kind of lava lobe cave in between the upper and lower lava flow.

Due to the elevation of approximately 2.000 m asl., the cave has been heavily weathered by wind and frost, and its interior is filled with loose debris. Overall, the cave appears more like an erosion-formed void than a remnant of a lava conduit, as it has developed predominantly within welded clasts that likely floated throughout the lava flow at the site of this lava lobe (fig 37b, 37c, 37d and 37e).

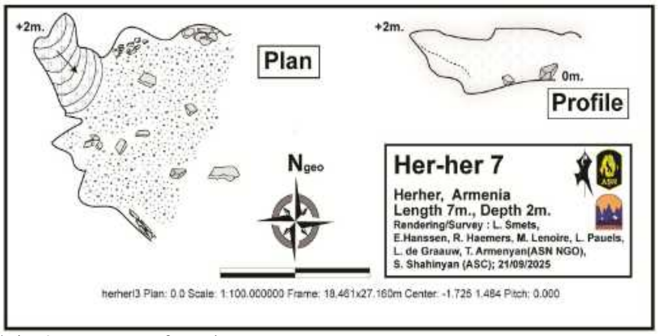
Fig. 37a: An old eroded lava stream-bed where Her-her 7 is located

Fig. 37b: Entrance of Her-her 7

Fig. 37c: Contact sediments from the upper lava flow and the older lower surface Her-her 7

Fig. 37d: Roof of welded clasts in Her-her 7

Fig. 38b: Lava clots at the entrance of Her-her 8



|Fig. 37e: Survey of Her-her 7

Her-her 8 features a spectacular entrance with all kinds of folded and tectonical shifted lava structures. The cave is located on the eastern slope of the valley near the village of Herher.

Like its neighbours Her-her 1 and 2, this cave is situated on the same hillside, which, according to geological maps, originates from late Oligocene eruptions. However, the relatively fresh appearance of the rock suggests it may instead be an outcrop from more recent lava flows of Vayots Sar Volcano.

Her-her 8 has a total length of 17 m, with an entrance height of nearly 9 m. Due to its spectacular combination of folded and tectonically deformed lava, this site could be highly interesting and worthy of a detailed geological study (fig 38a, 38b, 38c and 38d).

Fig. 38a: Entrance of Her-her 8

Fig. 38c: Inside Her-her 8

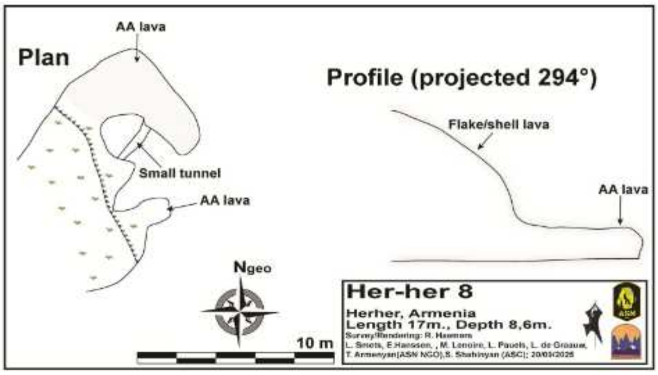


Fig. 38d: Survey of Her-her 8

Her-her 9 is a cave containing remnants of solidified lava. In one corner, the remains of a lava tube can be observed, including lateral erosion features and solidified lava within the void.

In recent times, the cave has been used as a den by wild animals. It is situated on the slope of a deep, ancient valley, likely carved during glacial periods, while the volcanic rock itself dates back to the late Oligocene (fig 39a, 39b, 39c and 39d)

Fig. 39a: Entrance of Her-her 9

Fig. 39b: Inside of Her-her 9

Fig. 39c: Remnants of a solidified lava flow

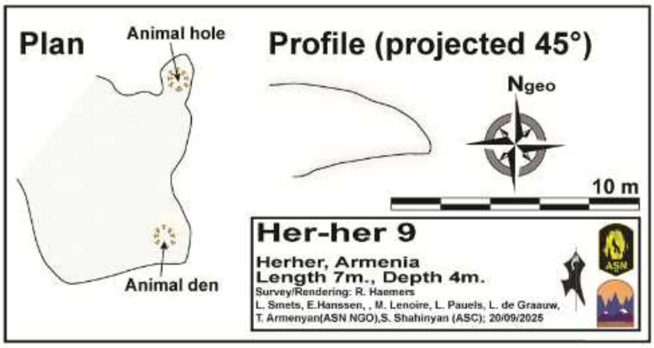


Fig. 39d: Survey of Her-her 9

Her-her 10 is a subcrustal cave formed where a lava flow was crusted over by welded floating clasts. The cave is situated within the lava flows on the eastern slope of Vayots Sar Volcano and is estimated to have formed during the Pleistocene, over 40,000 years ago.

Located on a slope, the cave has been heavily affected by tectonic movements, evident from the fractured and unstable interior. Like several other caves in the area, it has also been used by wild animals, as indicated by the presence of faeces inside the cavity (fig 40a, 40b and 40c)

Fig. 40a: Entrance of Her-her 10

Fig. 40 b: View into the valley from Her-her 10

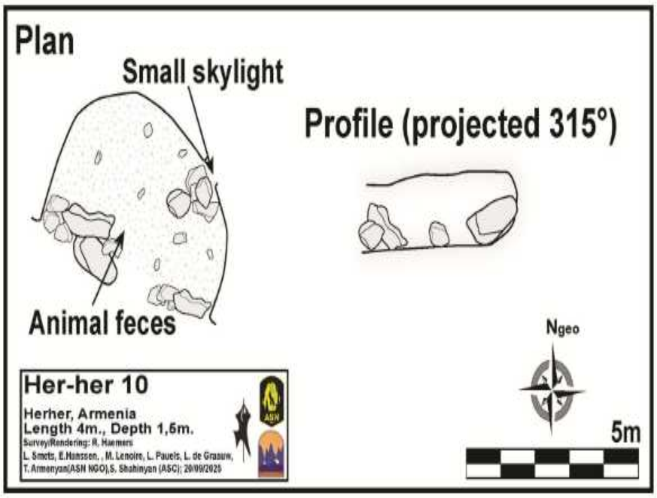


Fig. 40c: Survey of Her-her 10

Sisian 3 and 4 are two volcanic abris connected by a narrow crawl. The caves are located at the base of a slope northeast of the town of Sisian, with their neighbour being Sisian 5. The rock face hosting these caves represents an eroded lava tongue of late Pliocene age.

Sisian 3 and 4, connected through a crawl, measure 45m. in length and feature a height of nearly 7 metres. Due to the age of the surrounding landscape and ongoing tectonic activity on the slope, both inside and outside the caves show evidence of rockfalls.

The caves are likely lava tongue cavities: voids at the terminus of a lava flow, in between lava lobes, partly uplifted by gas, emptying out of lava and eroded by wind and water (fig 4a, 41b, 41c, 41d, 41e).


Fig. 41a: Entrance of Sisian 3 and 4 with welded clasts


Fig. 41c: Start of the crawl between Sisian 3 and 4


Fig. 41b: View from inside of Sisian 3 + 4


Fig. 41d: Looking outwards from Sisian 3

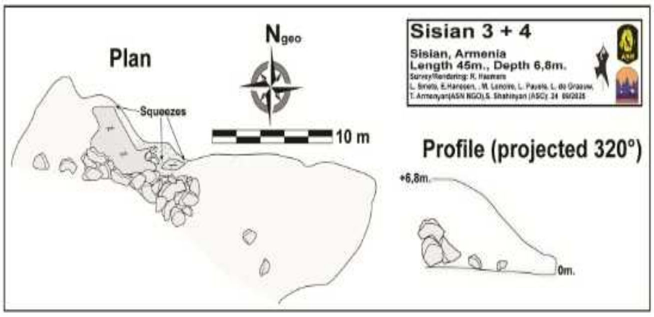


Fig. 41e: Survey of Sisian 3 and 4

Sisian 5, like its neighbours, Sisan 3 and 4 is located in an eroded lava tongue at the northeastern edge of the town of Sisian. The cave is formed within the eroded cliff of an old lava flow of late Pliocene age, originating from volcanic eruptions to the east. Several voids in this cliff have been used as shelters by both humans and animals.

The cave shows evidence of modification: the floor has been dug deeper, smoothed, and loose rocks were removed. One wall has been altered to serve as a nearly 4 m long feeding trough for larger animals, such as cows, goats, and sheep. At one side a solidified lava flow feature can be found inside the cave composed of welded clasts. Also some parts of the roof feature welded clasts. This mixture is likely the result of tectonic activity and/or human modification (fig. 21a - 21e).


Fig. 42a: View on the entrance of Sisian 5


Fig. 42b: Entrance of Sisian 5 with welded clast in the roof



Left: fig. 42c: Solified lava flow of welded clasts inside Sisian 5. Right: fig. 42d: View into the valley from Sisian 5

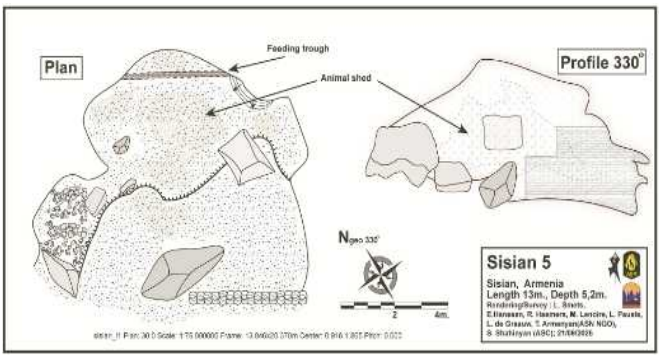


Fig. 42e: Survey of Sisian 5

Sisian 6 is located on a slope within an eroded valley east of the town of Sisian. The valley was most likely shaped and worn down during glacial times. Due to its age and tectonic activity, the cave is highly unstable, with evidence of rockfalls both inside and outside the cavity.

The cave is probably a remnant of voids in between lava lobes, eroded afterwards and cut off by tectonics causing rockfalls (fig. 43a - 43d).


Fig. 43a: View on the rockface of the entrance of Sisian 6


Fig. 43b: The small entrance behind a rock of Sisian 6


Fig. 43c: The fractured and collapsed interior of Sisian 6

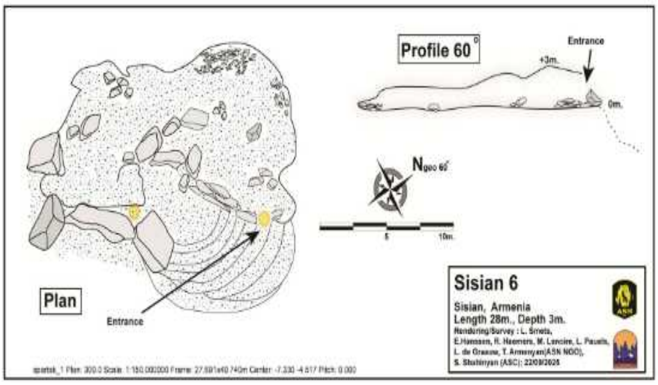


Fig. 43d: Survey of Sisian

The Angheghakot caves 2 – 10

The caves known as Angheghakot are situated on the slopes of the Vorotan Gorge, east of the village of Angheghakot. The gorge was not carved out during the Ice Age but was formed by ongoing river erosion in the post-glacial period. According to geologists, the surface in this area dates to the late Pliocene–Early Pleistocene (~3.6–0.8 Ma). The predominant rock types are trachybasalts and basaltic trachyandesites.

The Vorotan Gorge has a rich anthropological history. After the climate stabilised following the glacial periods, humans inhabited the gorge during the Stone Age. Excavations by the Research Centre of Historical and Cultural Heritage between 2012 and 2021 uncovered late Acheulian bifaces, a specific class of prehistoric stone tools, on plateaus at the headwaters of the Vorotan, at elevations of 2,200–2,300 m asl.

Volcanic obsidian found in the Arteni, Hatis, and Nemrut mountains, as well as in the Vorotan River basin, Kotayk plateau, and other mining sites, was not only processed locally but also exported in significant quantities to neighbouring regions, particularly southwest Asia.

Angheghakot 2–10 are a series of similar caves, all sharing the same origin. They are located at the base of large lava pillar walls that form the highest part of the Vorotan Gorge. Over time, weathering and erosion caused parts of the pillars to collapse, forming slopes and accumulations of rock debris in front of the caves. All caves are situated at roughly the same elevation, around 1,800 m a.s.l. Some smaller entrances were obstructed by recent rockfall requiring the removal of blocks to gain access.

The caves most likely represent weaker voids formed between two separate lava flows with different geological structure or sediment, comparable to voids found between lava lobes.

Many caves display clear signs of tectonic disturbance, while others seem to have been altered or cleared by human activity. In addition, natural erosion such as water, wind, ice, and frost have reshaped the caves over millions of years.

The alteration of most of the caves was likely carried out to make them suitable as shelters for humans and/or animals. Floors were typically smoothed, loose rocks removed, and small walls of stones were sometimes constructed inside or outside the caves. Due to these historical modifications, all of the Angheghakot caves are considered to have significant archaeological value.

Angheghakot 2 and 3


Fig. 44a: Entrances of Angheghakot 2 and 3


Fig. 44b: Eroded interior of Angheghakot 2 and 3

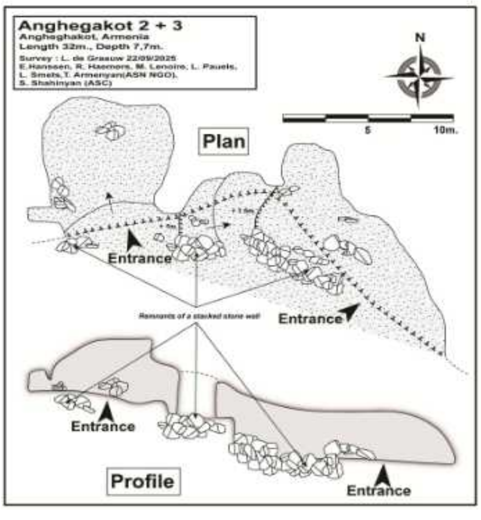


Fig 44c: Survey of Angheghakot 2 + 3

Angheghakot 4

Fig. 45a: Entrance of Angheghakot 4

Fig. 45b: View out of Angheghakot 4

Fig 45c:
A triangular structure inside Angheghakot 4

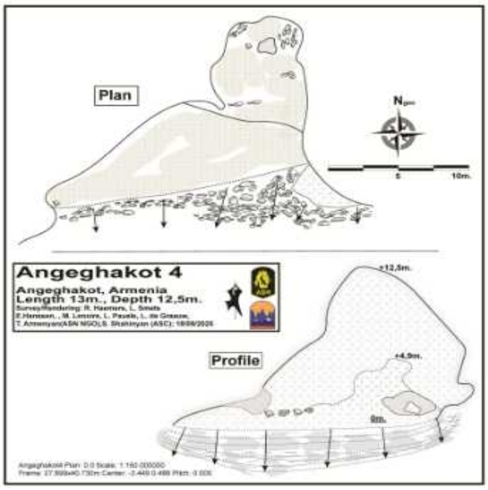


Fig. 45d : sSurvey of Angeghakot 4

Angheghakot 5

Fig. 46a: Entrances of Angheghakot 5

Fig. 46b: Angheghakot 5 west entrance

Fig. 46c: Brickwalls with a crawl connection Angheghakot 5

Fig. 46d: Looking outwards Angheghakot 5

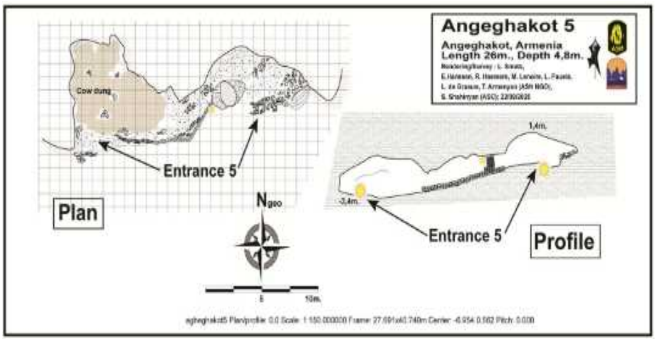


Fig. 46e: Angheghakot 5

Angheghakot 5.1

Fig. 47a:
Dug out entrance of
Anghaghakot 5.1

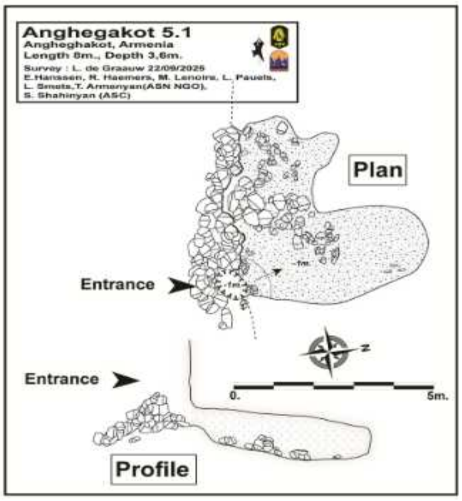


Fig. 47c: Survey of
Angheghakot 5.1

Fig. 47b: Location of Angheghakot 5.1

Angheghakot 6

Fig. 48a: Entrance of Angheghakot 6 with above the pillar lava

Fig. 48b: Entrance of Angheghakot 6

Fig. 48c: Interior of Angheghakot 6

Fig. 49b: Interior of Angheghakot 7

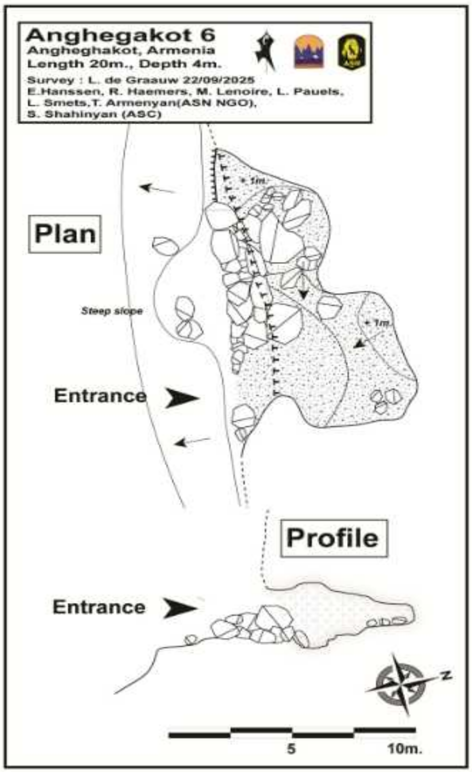


Fig. 48d: Survey of Angheghakot 6

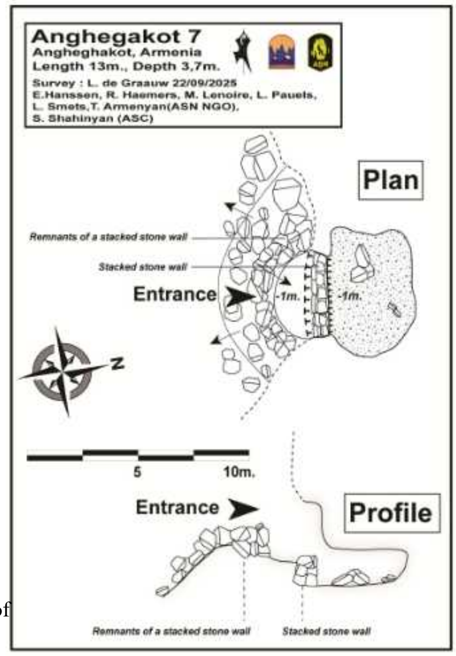


Fig. 49c: Survey of Angheghakot 7

Angheghakot 7

Fig. 49a: Entrance of Angheghakot 7 with piled blocks

Angheghakot 8 and 9

Fig. 50a: At left entrance Angheghakot 9 , at right Angheghakot 8

Fig. 50b: Entrance of Angheghakot 9

Fig. 50c: Looking out ofAngheghakot 9

Fig. 50d: Former archaeological dig inside Angheghakot 9

Fig. 50e: Khachkar at the entrance of Angheghakot 9

Left up: Fig. 50f paintings in Anghaghakot 9 .
Right: Fig. 50g and 50h: interior of Angheghakot 8 .

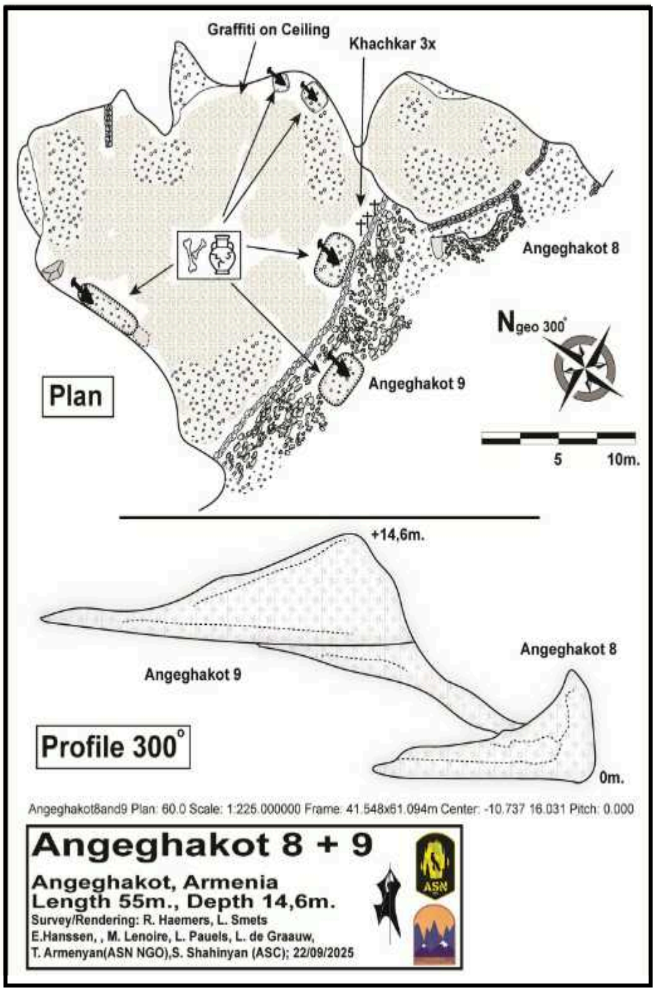


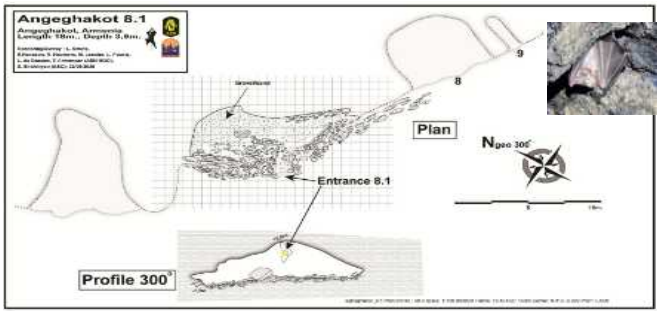
Fig. 50i: Survey of Angheghakot 8, and 9

Angheghakot 8.1

The entrance to **Angheghakot 8.1** is very small and unstable. It had been blocked by fallen blocks from collapsed lava pillars above, and the team had to carefully remove the debris to gain access. The interior is filled with rocks. Inside the cave, one of the first bats was observed.

Left: Fig. 51a entrance. At right: Fig.51b interior of Angheghakot 8.1

Down: Fig. 51c and 51d: Survey of Angheghakot 8.1 and bat inside



Angheghakot 10

Fig. 52a: Location of Angheghakot 10

Fig. 52b: Abri of Angheghakot 10

Fig. 52c: Interior and its former archaeological dig of Angheghakot 10

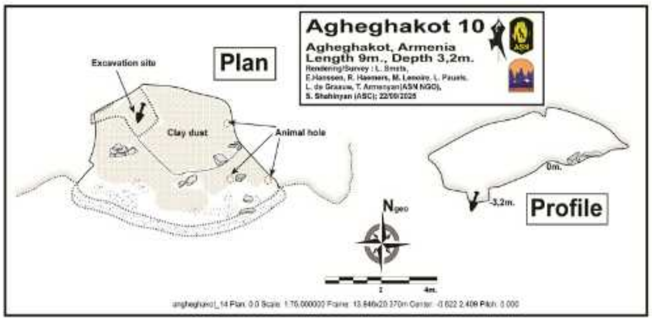


Fig. 52d: Survey of Angheghot 10

Fig. 52e: Looking out Angheghakot 10

The Vorotan Gorge

Fig 53: View from one of the caves into the Vorotan gorge

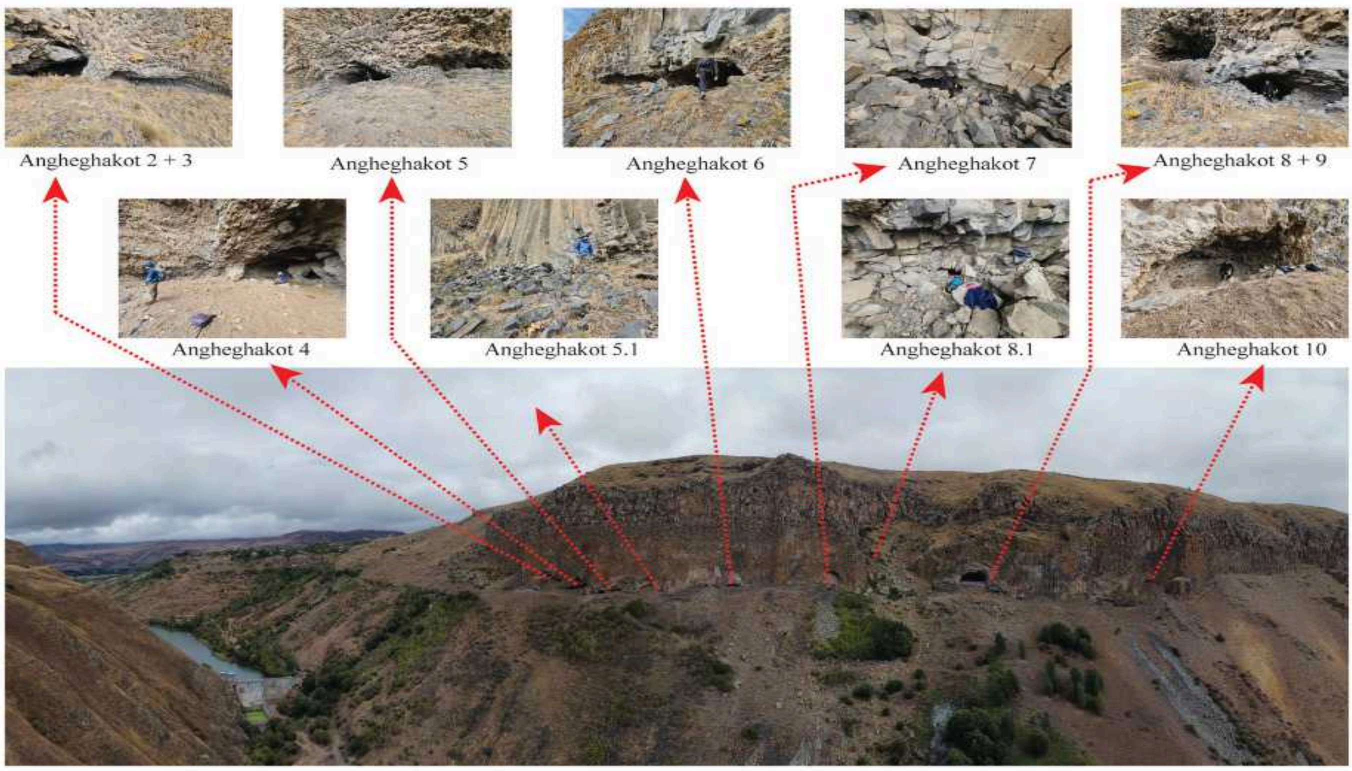


Fig 54: a drone view onto the North side of the Vorotan gorge showing the locations of the Angheghakot caves

Conclusion

After eight days exploring selected areas of Armenia, we gained valuable insights into the country's volcanic speleological potential. During this period, we evaluated and explored more than 40 volcanic caves and related features, with a total surveyed length of nearly 610 m.

Following our initial reconnaissance trip in 2024, during which we documented approximately 20 caves with a total length of approx. 175 m, our understanding of Armenian volcanic geology has significantly improved. We now have a better understanding of which areas may host underground lava conduits. A major success of this expedition was the collaboration with several prominent Armenian geologists, combining local knowledge with our speleological expertise.

The joined effort has enhanced understanding on both sides - not only of underground volcanic processes, but also of scientific collaboration - and we hope this will lead to further discoveries. Continued exploration of volcanic caves, particularly within national parks, is expected to yield valuable data for geologists and other researchers, supporting the study and conservation of Armenia's unique natural environment.

Acknowledgement

This paper is indebted to a very large number of colleagues, cavers and friends who supported the team in the field, as well as to those who generously shared their insights and observations on Armenia's volcanic phenomena. Not all of these can be mentioned here but we are specifically grateful to *Professor Samvel Shahinyan* from the Armenian Speleological Centre, Tigran Armenyan from *Arm Speleo Network NGO,* Dennis Verbrüggen for providing material as well as Speleo Nederland for their financial support. Furthermore, we owe our gratitude to Dr. Stephan Kempe for sharing his knowledge, which was essential for observing and identifying the caves found in certain types of volcanic areas.

References:

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-Kharazyan E,Kh., Geological map of Republic of Armenia scale 1: 500.000, 2005, Yerevan

Fig 55 List of volcanic caves surveyed in 2025

Date surveyed	Place	Height asl	length	depth	NAME Tigran
9/22/2025	Angeghakot	1825	13	12,5	Angheghakot 4
9/22/2025	Angeghakot	1804	32	7,7	Angheghakot 2+3
9/22/2025	Angeghakot	1779	26	4,8	Angheghakot 5
9/22/2025	Angeghakot	1792	8	3,6	Angheghakot 5.1
9/22/2025	Angeghakot	1816	20	4	Angheghakot 6
9/22/2025	Angeghakot	1796	13	3,7	Angheghakot 7
9/22/2025	Angeghakot	1804	55	14,6	Angheghakot 8 + 9
9/22/2025	Angeghakot	1814	18	3,9	Angheghakot 8.1
9/22/2025	Angeghakot	1827			Angheghakot 9
9/22/2025	Angeghakot	1817	9	3,2	Angeghakot 10
9/24/2025	Herher	1783			
9/24/2025	Herher	1636	9	3,7	Her-her 1
9/24/2025	Herher	1636	7	2	Her-her 2
9/24/2025	Herher	1818	5		Her-her 3
9/24/2025	Herher	2106	23	5,2	Her-her 4
9/24/2025	Herher	1799	18	2,3	Her-her 5
9/24/2025	Herher	1799	4	2	Her-her 6
9/24/2025	Herher	2004	7	2	Her-her 7
9/24/2025	Herher	1797			
9/20/2025	Herher	1653	17	8,6	Her-her 8
9/20/2025	Herher	2023	7	4	Her-her 9
9/21/2025	Herher	2060	4	1,5	Her-her 10
9/21/2025	Sisian	1623	13	5,2	Sisian 5
9/21/2025	Sisian	1658	45	6,8	Sisian 3,4
9/22/2025	Spartak	1660	28	3	Sisian 6
9/17/2025	Sevan	2361	12	3	Geghama 1
9/17/2025	Sevan	2341	9	2,7	Geghama 2
9/17/2025	Sevan	2388	10	3	Geghama 3
9/20/2025	Vayots sar	1576	8	2,6	Vayots 4
9/20/2025	Vayots sar	1565	36	7,9	Vayots 2
9/20/2025	Vayots sar	1541	11	2,9	Vayots 1
9/20/2025	Vayots sar	1616	6	0,8	Vayots 5
9/20/2025	Vayots sar	1540	9	3	Vayots 3
9/20/2025	Vayots sar	1606			
9/20/2025	Vayots sar	1603	16	4,5	Vayots 6
9/18/2025	Verin Getashe	1974			Verin Getashen 1
9/18/2025	Verin Getashe	1963	16	6	Verin Getashen 2
9/18/2025	Verin Getashe	2001	80	5	Verin Getashen 1
9/18/2025	Geghhovit	2204	15	3	Geghhovit 1
			609		

MEMORIES OF PHIL COLLETT (1943 – 2025)

By Martin Mills

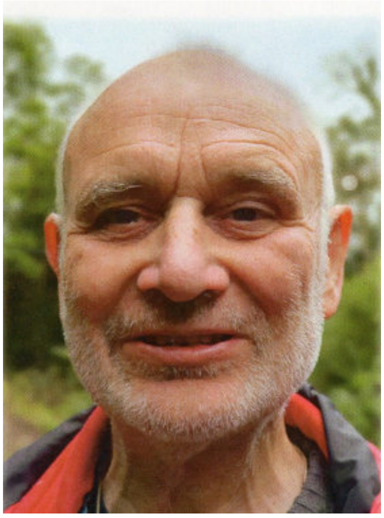


Photo by Sean Howe, SMCC

Phil Collett, the well-known British caver and member of the Commission on Volcanic Caves passed away on 7th November 2025, aged 81. As I have known him throughout the decades, I thought I should provide some recollections.

Phil entered his first cave aged 2¾ in Cheddar. He joined the Shepton Mallet Caving Club (SMCC) in 1972 and remained a member until his passing. Prior to joining the Club, he attended Imperial College, London, where he started cave diving and joined the Cave Diving Group (UK) as a trainee diver in 1966, which was the year of his first cave dive. The following year, in August 1967 he was on a University of Bristol/Cave Diving Group expedition diving in Czechoslovakia and became a qualified diver that year. The following year, 1968, he was on a Speleo Club de Paris expedition diving in Turkey, involving a three day drive each way from the UK.

James Cobbett from Panama writes:

"In 1969, Phil and I were the only two divers on the Exeter University expedition to the Middle Atlas in Morocco, with ambition to link up the 500 foot (~152m) surface entrance pitch of the Frioato to the stream entering the main passage of the Chikker cave, some distance away. Though we explored a lot of passage past the Frioato static sumps, some new, we did not find a way on towards the Chikker. However, on the last trip, returning from the end, we found ourselves in a chamber we had not passed on the way in, so big that our lights did not reveal the opposite walls or ceiling, or the passage by which we had entered. After a little more than an hour's desperate searching, we found the way back out to the static sumps, with no harm done. This 1969 expedition seems to be the last significant exploration of the Frioato, no one having been back since, with many leads still waiting to be pushed."

While at Imperial College Phil also took part in the British Karst Research Expedition to the Himalayas, 1970. With 10 others, led by Tony Waltham, they traveled overland to Kashmir and Nepal and to the foot slopes of Annapurna. This return trip took just over four months, over 22,000km, traveling in an ex Civil Defence fire tender which they had bought and modified. In October 1977 I attended a caving club dinner in Buxton (Derbyshire). The guest speaker was Tony Waltham who gave a suitably humorous illustrated talk on what might go wrong on expeditions. I still remember hearing of someone swimming a raging Himalayan river to put a large amount of fluorescent dye into a sink spotted in the far river bank, only for it to reappear 20 metres or so downstream and colour the river green for days. Most likely, the swimmer was Phil. A similar incident caused a temple's fountain to cascade green.

In September 1973, Phil hitch-hiked across Canada to remote Arctomys Cave in Mount Robson Provincial Park, British Columbia where a large Canadian expedition team had assembled, including the legendary Mike Boon. The previous year the cave had been pushed to a depth of 296m, to be stopped by a large waterfall. With difficulty, this time the bottom was eventually reached at a depth of 523m to become the North American depth record.

At Christmas 1975, with Pete Lord, Phil flew to New York, then to Ohio by Greyhound bus and then drove non-stop, day and night, to Mexico with Bill Banner in his V8 Ford Van. Three of the big shafts were bottomed, including Golondrinas (320m pitch). Many international cavers were in Mexico at the time, including one Julia James!

For the next quarter century Phil was here (in the UK), there and everywhere, principally in Europe, exploring limestone caves, including in 1977 a Christmas/New Year trip with the writer to the Hölloch in Switzerland, then the second longest limestone cave in the world at 135km, which took three days with two overnight bivouacs to get to Pagoda Passage in the further reaches of the system.

As far as I am aware, Phil's first encounter with lava caves was in September 2000 in Iceland. SMCC had had an interest in lava caves since 1970 but it had waned in subsequent decades. Phil's initiation undoubtedly came via the late Chris Wood. Chris had been a member of the club from 1966 to 1992 but even thereafter he always maintained contact as undoubtedly, he viewed members as a reliable and interested source of manpower for his ongoing volcano research. When Chris took up his last appointment at Bournemouth University, an opportunity must have arisen to take some students, (including from Dundee University) to Iceland on a field trip, and he invited several members of SMCC, including Phil, to take part. As a prelude to the 2000 Laki Underground Expedition (August/ September), one of the sponsors, who was lending a Land Rover, also sponsored a one-day 4x4 driving course in the UK. Phil was one of the two Laki attendees and clearly enjoyed the experience as he wrote it up, unusually, in great detail in the SMCC newsletter. In addition, after the Laki investigation, the team also went to the Hallmundahraun to pursue geophysical investigations. Included in the party were two Australians, one of whom was Greg Middleton. In July 2001 there was a second trip to Laki. In these two expeditions over 11km of lava tube was discovered and surveyed. Prior to this only 530m were known.

As a result of all the surveying that had been done, and an article "Developments in Expedition Cave Surveying", published in 2004 in the SMCC Journal, the British Cave Research Association awarded him jointly with two others the coveted Arthur Butcher Award for Cave Surveying at the annual British caving conference in 2012.

The following year, 2003 (May/June) there was a SMCC trip to the Reykjanes Peninsula, Iceland. In 2004 (September), Phil went with Björn Hróarsson, to reconnoitre the Ódáðahraun, the largest lava field in Europe at 6000km², and they relocated Grettishellir, in the Kjalhraun, West Central Iceland, not visited for 30 years.

In 2005, June, Phil joined a brief SMCC trip to Reykjanes, Iceland to survey the new Buri lava tube, 720m long, followed by a larger expedition in August that year to Ódáðahraun.

In November 2006 Phil went to Goðahraun near ingvellir to survey a couple of caves, then attended Bjorn's book launch (Íslenskir Hellar – two volumes in slip case with Icelandic text). In 2007 (July), joined a a further SMCC expedition to Ódáðahraun, Iceland.

In 2011, (December), Phil was on a long weekend digging trip at the end of Buri and also visited Raufárholshellir and Bláfjöll (last visited in 2003).

In the summer of 2012 there was the epic Cod's Grand Tour of Iceland with Geraldine and friends, visiting popular tourist destinations. (Phil Collett had become known as Cod Fillet over the years.)

In December 2014 Phil took a solo trip to Iceland to fly over and photograph the Bárðabunga eruption.

During 11 his visits to Iceland from 2000 to 2014, listed above, as far as can be ascertained, a total of at least 22km of new lava tube was discovered, explored and surveyed, together with a significant additional amount of surveying in known lava tubes.

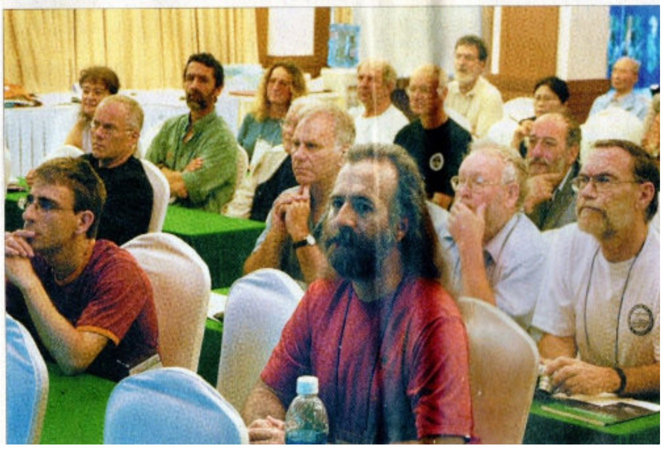
Apart from all Phil's visits to Iceland, there were two other lava encounters at other destinations: October 2004, with Geraldine, on Sicily where they walked up Mt Etna to see the eruption in the Valle de Bove and examine flowing lava from a (safe?) distance.

In March/April 2006 he was tourist caving on Lanzarote, Canary Island, visiting five known volcanic caves.

Between 2004 and 2024 Phil was also limestone caving with at least 27 visits to Thailand and more recently Laos and Myanmar and visited at least 500 limestone caves.

Phil attended several UIS International Congresses of Speleology (ICS), including the 12th in 1997 at La Chaux-des-Fonds, Switzerland, and the 16th at Brno, Czech Republic in July 2013

Phil and Geraldine at Final Dinner, 16th ISC, Brno, Czech Republic in July 2013. Photo K Mills



This is a commercial photo of the Jeju Volcanic Caves Symposium (ISV13), which appeared on the front page of the Jeju Times, 2nd September 2008. Phil is in the middle, third row back, wearing a black Symposium t-shirt, sitting next to the author.

Phil and the author flanked by Andy Eavis and Rene Scherrer, ISV13, Jeju Island, Korea, 2008. Photo: John Brush

Phil participated in five of the Commission's International Symposia on Vulcanospeleology (ISV): at Jeju Island, South Korea in September 2008; Galapagos Islands in March 2014; Hawaii, USA, in February/March 2016; Lava Beds National Monument, California, USA in July/ August 2018 and Dak Nong, Vietnam in November 2022.

Phil didn't write much unless inspired – fortunately others did (!) which has greatly assisted in writing these recollections but there is one doubtful omission. As will be apparent, he didn't let the grass grow under his feet. How many countries did he visit? Probably nobody knows…..

Condolences to Geraldine, their daughters Clare and Sarah, and all the family.

Phil and Geraldine with other participants at morning tea, ISV20, Dak Nong Province Vietnam, November 2022. Photo: Phaithoun Somepilavong ("Noy")

Phil and Geraldine enjoying a modest banquet with ISV20 participants, Dak Nong Province Vietnam, November 2022. Photo: Phaithoun Somepilavong ("Noy")

Phil in at the Volcano Symposium, Jeju Island, South Korea, September 2008. Photo K Mills

Phil (at rear) with Harry Mariakis & Marjorie Coggan in Sunshine Cave, Lava Beds California (ISV18, July 2018). Photo: John Brush

Phil in Hercules Leg Cave, Lava Beds California (ISV18, July 2018). Photo: John Brush

Volcanologists Cheryl Gansecki (University of Hawaii at Hilo) and Richard Hazlett at Uekahuna Bluff at the northwest rim of Kaluapele (Kilauea Caldera) during a major lava fountaining episode 1.5 km away, on 9 November, 2025. The fountains of molten lava rise between 300-500 m and are shedding a blanket of reticulite (basaltic pumice) and coarse glassy ash downwind to the southwest. Tephras from recent events such as this have buried the famous 1790 CE human footprint localities 11 km away. Gansecki and Hazlett are co-authors together with Steven Lundblad of 'Roadside Geology of Hawaii' (Geological Society of America).