

The Pico del Oro Plateau Caving Expedition in 2023

25th August – 20th September 2023

An International Expedition that is part of a wider series of North Perú Caving Expeditions organised by Espeleo Club Andino (Perú) and Groupe Spéléo Bagnols Marcoule (France)

Sponsored by the Mount Everest Foundation and the Ghar Parau Foundation, and supported by Firepot and Adventure Nutrition dehydrated meals.



Summary

This highly successful international expedition explored major new caves on the high-altitude (> 3,250-3,550m) Pico del Oro Plateau in North Perú (Figs. 1-3), forming part of a wider series of GSBM-ECA expeditions across Perú (www.cuevasdelperu.org; Nord Perú 2018, 2019, and 2022). This high plateau has significant potential for deep caves, as it is potentially underlain by limestone units that may have up to 2,700 m of relief, and it is situated above a very large (~24 m³/s median up to 35 m³/s peak) resurgence of the Rio Negro River (Fig. 2; Baby 2020, 2023). Previously, small expeditions in 2018-2022 had explored a major river sink (Fig. 2-4; Tragadero 1 de la Planura del Pico del Oro; Nord Perú 2019, 2022; Bigot, 2018, 2019) that was choked and impassable, which lies towards the edge of the high plateau (Fig. 3). A small expedition in ECA-GSBM-UK expedition in 2022 also identified a cave entrance (Tragadero de la Soledad; Nord Perú, 2022; Talling, 2023) just above the first of a set of major river sinks towards the west of the plateau (Fig. 3). This 2023 caving expedition returned to the plateau with a larger international caving team and more caving equipment, as well as dehydrated food, stoves and equipment needed for lightweight satellite camps.

The 2023 expedition was very successful, and discovered a series of major caves that demonstrate the world-class potential of this high plateau, and its potential to host deep caves. Initially, the expedition formed two groups of 5 cavers, who explored two areas of the plateau. The first team explored two new caves that are almost completely vertical (Lorenzo's Right Eye and Left Eye) to the east of the plateau, in very challenging terrain beyond Tragadero 1 de la Planura del Pico del Oro (Fig. 3). These river sinks were shown to us by our local Peruvian guide (Lorenzo), and they were left ongoing (and getting bigger) at -141 and -158 m, with further vertical pitches of ~40 m in both cases. Both caves also have a strong draft, and need significantly more rope. These vertical caves lie ~2,420 m above the very large Rio Negro resurgence at the base of the plateau, which is the start of a major tributary to the Amazon, has an unusually cold temperature, and may thus drain quickly from a higher area. These two vertical caves are active river sinks, so ropes had to be rigged carefully out of potential floodwaters. They were located ~2 hours walk across very challenging karst terrain from a satellite camp at Tragadero 1 de la Planura del Pico del Oro (Fig. 1). A new satellite camp has been identified near to these cave entrances that may be accessed by horses in 2024.

A second team of 5 cavers explored a line of ~12 major river sinks that form a NW-SE line, and are ~10 km further away from the plateau-edge and Rio Negro resurgence. The first of these river sinks, whose entrance was visited during the 2022 reconnaissance trip (previously called Bigger Sink, and now renamed Tragadero de la Soledad), went down a series of ~65 m of short entrance pitches to a major streamway, which is exceptionally well decorated (some of this very experienced caving team think it is the most beautiful streamway they have seen worldwide). This near-horizontal streamway continued for ~2 km to a large chamber, and a junction with an even larger and more decorated streamway that sumped after 0.5 km and a 40 m pitch. However, there is a strong draft before this sump, and there may be a climb into a large overlying passage that is ~30 m high, which will need to be explored in the future. This second larger streamway is heading NE and directly towards the two vertical potholes explored by the first team, and the very large and cold Rio Negro resurgence at the base of the plateau. All of the caving expedition members then combined to explore and map the currently 2,350m long and -205 m deep Tragadero de la Soledad. The second team also made a brief reconnaissance trip to a series of 5 further major river sinks (Sinks 2-6), some of which look promising. One sink (Sink 2) was explored for > 200 m and was left wide open, although with bad air. Sink 5 also look particularly promising, with a <5m entrance pitch, which was left undescended.

Overall, the expedition was really successful, and it now demonstrates that the Granada Plateau contains world class caves. The expedition team will now need to return in 2024, with a much larger amount of rope and rigging gear, as the 650m of rope and rigging gear carried onto the plateau by this 2023 expedition had been placed down major caves by day 5 of 14 of this 2023 expedition.

Resumen

Esta expedición internacional fue de gran éxito, se exploró nuevas cuevas importantes en la meseta de **Pico del Oro** en el norte de Perú (Figs. 1-3), la cual es de gran altitud (> 3.250-3.550 m). La expedición formó parte de una serie más amplia de expediciones organizadas por el GSBM-ECA en todo Perú (www.cuevasdelperu.org ; Norte del Perú 2018, 2019 y 2022).

La meseta explorada tiene un potencial significativo para cuevas profundas, ya que está potencialmente ubicado sobre unidades de piedra caliza que pueden tener hasta 2.700 m de desarrollo, y está situado en la parte alta de la importante resurgencia del río Negro (~24 m³/s mediana hasta 35 m³/s pico) (Fig. 2; Baby 2020, 2023). Anteriormente, pequeñas expediciones en 2018-2022 habían explorado un sumidero fluvial importante (Fig. 2-4; Tragadero 1 de la Planura del Pico del Oro; Nord Perú 2019, 2022; Bigot, 2018, 2019) que estaba colmatado e impenetrable, ubicado en el borde de la meseta alta (Fig. 3). Una pequeña expedición del ECA-GSBM-UK en 2022 también identificó una entrada a una cueva (Tragadero de la Soledad; Nord Perú, 2022; Talling, 2023), localizado justo antes del primer sumidero de un conjunto de grandes sumideros fluviales hacia el Oeste de la meseta (Fig. 3). Para la expedición espeleológica de 2023 se regresó a la meseta Pico del Oro, con un equipo más grande de espeleólogos internacionales y con más material de espeleología que los años anteriores, así como comida deshidratada, estufas y equipo necesario para campamentos satélites ligeros.

La expedición de 2023 tuvo mucho éxito, ya que se descubrió una serie de cuevas importantes, que muestran el potencial mundial de la meseta explorada, y su potencial para albergar cuevas profundas. Inicialmente, la expedición se dividió en dos grupos de 5 espeleólogos, que exploraron dos zonas de la meseta. El primer grupo exploró, al Este de la meseta, dos nuevas cuevas casi completamente verticales (Ojo Derecho y Ojo Izquierdo de Lorenzo), en un terreno muy desafiante, más alejado del Tragadero 1 (Fig. 3). Estos sumideros fluviales fueron mostrados por nuestro guía local peruano (Lorenzo), y quedaron en curso de exploración (y haciéndose más grandes) a -141 y -158 m, con

verticales de ~40m no bajadas en ambos casos. Ambas cuevas también tienen mucha agua, y necesitan bastante más cuerda. Estas cuevas verticales se encuentran a unos 2.420 m por encima de la gran surgencia del Río Negro, ubicada en la base de la meseta, la cual es el inicio de un importante afluente del río Amazonas; además trabajos anteriores han demostrado que tiene una temperatura inusualmente fría (y por lo tanto puede drenar una gran área). Estas dos cuevas verticales son sumideros de ríos activos, por lo que hubo que colocar las cuerdas con cuidado para evitar posibles inundaciones. Estaban situadas a ~2 horas a pie a través de un terreno kárstico muy difícil desde un campamento satélite en el Tragadero 1 de la planicie del Pico del Oro (Fig. 1). Se ha identificado una nueva zona, donde se podrá establecer un campamento satélite cerca de las entradas de estas cuevas al que se podrá acceder con caballos en 2024.

El segundo grupo, conformado igualmente por otros 5 espeleólogos, exploró una línea de ~12 grandes sumideros fluviales que forman una línea NO-SE, y están ~10 km más lejos del borde de la meseta y de la resurgencia del Río Negro. El primero de estos sumideros, cuya entrada fue visitada durante el viaje de reconocimiento de 2022 (anteriormente llamado Tragadero Grande, y ahora nombrado como Tragadero de la Soledad), descendía por tramos estrechos aproximadamente ~65 m hacia el cauce de un afluente más grande, que está excepcionalmente bien decorado de espeleotemas (algunos de este experimentado equipo de espeleólogos piensan que es el arroyo con las formaciones más bellas que han visto en todo el mundo). Este afluente casi horizontal continúa durante unos 2 km hasta un gran salón y hasta el cruce con un afluente aún mayor y con más espeleotemas, que se hunde unos 40 m después de 0,5 km. Sin embargo, hay una fuerte corriente de aire antes de la entrada de este sifón, y puede haber una entrada hacia un gran pasaje adyacente de 30 m de altura aproximadamente, el cual debería ser explorado en el futuro. Este segundo río más grande se dirige al NE y directamente hacia las dos simas verticales exploradas por el primer equipo, y hacia la grande y fría resurgencia del Río Negro en la base de la meseta. Posteriormente, todos los miembros de la expedición de espeleología se juntaron para explorar y cartografiar el Tragadero de la Soledad, que actualmente tiene 2.350 m de longitud y -205 m de profundidad. El segundo equipo también realizó un breve viaje de reconocimiento a una serie de otros 5 grandes sumideros fluviales (Sumideros 2-6), algunos de los cuales parecen prometedores. Otro sumidero (Sumidero 2) se exploró durante aproximadamente 200 m y aún presentaba continuidad, aunque con aire confinado. El sumidero 5 también parece especialmente prometedor, con un paso de entrada de <5 m, que se dejó sin descender.

En general, la expedición fue todo un éxito, y ahora se demuestra que la Meseta de Granada contiene cuevas de categoría mundial. El equipo de la expedición deberá regresar en 2024, con una cantidad mucho mayor de cuerda y demás materiales, ya que los 650m de cuerda y los materiales de anclaje llevados a la meseta para esta expedición de 2023 fueron usados en las principales cuevas en el día 5 de los 14 que duró en total la expedición de 2023.

Résumé

Cette expédition internationale très réussie a exploré de nouvelles grottes majeures sur un plateau de haute altitude (> 3 300 à 3 600 m) situé au nord du Pérou (Fig. 1-3), expédition qui s'intègre dans une longue série d'expéditions franco-péruviennes ECA-GSBM (www.cuevasdelperu.org, Nord-Pérou 2018, 2019 et 2022). Ce haut plateau présente un potentiel important de gouffres profonds, car il repose sur des unités calcaires pouvant atteindre 2 700 m d'épaisseur. Ce plateau est par ailleurs situé au-dessus de la puissante résurgence du Rio Negro (~ 24 m³/s en moyenne, pics à 35 m³/s). Auparavant, des expéditions ECA-GSBM avaient exploré une perte importante (Tragadero 1 de la Planura del Pico del Oro), rapidement obstruée et infranchissable, située au bord du plateau oriental (Fig. 3). L'expédition ECA-GSBM-UK en 2022 a également reconnu plusieurs cavités dont le Tragadero de la Soledad, la première d'un ensemble de pertes importantes situées vers l'ouest du plateau (Fig.

3). Cette expédition Nord-Pérou 2023 est revenue sur le plateau avec une équipe internationale plus nombreuse et davantage de matériel, ainsi que de la nourriture déshydratée, des réchauds et du matériel nécessaire aux camps satellites légers.

L'expédition 2023 a connu un succès exceptionnel et a permis la découverte de cavités qui démontrent le potentiel de classe mondiale de ce plateau et sa capacité à abriter des gouffres profonds. Initialement, deux équipes de 5 spéléologues exploraient deux parties différentes du plateau. **La première équipe** a exploré deux nouveaux gouffres complètement verticaux (l'œil droit et l'œil gauche de Lorenzo) à l'est du plateau, dans un terrain très difficile qui se trouvait à plusieurs kilomètres au-delà du Tragadero de la Planura del Pico de Oro (Fig. 3). Ces pertes (tragaderos) nous ont été indiquées par le guide péruvien (Lorenzo). Ces deux cavités explorées jusqu'à -141 m et -158 m, continuent et s'agrandissent, avec des verticales supplémentaires d'au moins ~40 m dans les deux cas. Les deux gouffres sont très arrosés, et nécessitent donc plus de corde. Ces deux entrées se trouvent à environ 2 420 m au-dessus de la résurgence du Rio Negro à la base du plateau. Des travaux antérieurs ont montré une température inhabituellement froide des eaux de cette résurgence, attestant l'existence d'un drainage souterrain important. Ces deux pertes sont actives, les cordes ont donc dû être soigneusement installées pour éviter les crues potentielles. Elles sont situées à environ 2 heures de marche sur un terrain karstique très difficile depuis le camp satellite installé à côté du Tragadero de la Planura del Pico del Oro (Fig. 1). Un nouveau camp satellite accessibles aux chevaux a été identifié à proximité de ces cavités.

Une deuxième équipe de 5 spéléologues a exploré une ligne de pertes plus importantes, situées à environ 10 km du bord du plateau et de la résurgence du Rio Negro. La première de ces pertes, dont l'entrée a été visitée lors de la campagne de reconnaissance 2022 (appelée alors Bigger Sink, et maintenant nommée Tragadero de la Soledad), descend sur environ 65 m de profondeur jusqu'à un collecteur plus important, exceptionnellement bien concrétionné (certains membres de l'équipe très expérimentés pensent que c'est la plus belle rivière souterraine qu'ils ont vu dans le monde entier). Ce cours d'eau presque horizontal se poursuit sur environ 2 km jusqu'à une grande salle et une jonction avec un cours d'eau encore plus grand et plus décoré, qui se termine sur un siphon après 0,5 km de galerie et un puits de 40 m. La galerie présente un fort courant d'air avant ce siphon, et il semble y avoir un moyen de le court-circuiter par un passage situé 30 m plus haut, qui devra être exploré en 2024. Cette deuxième rivière plus importante se dirige vers le nord-est, directement vers les deux gouffres explorés par la première équipe, et vers la grande et froide résurgence du Rio Negro située au pied du plateau. Tous les membres de l'expédition se sont ensuite réunis pour explorer et cartographier le Tragadero de la Soledad, actuellement long de 2 350 m et profond de -205 m. Cette deuxième équipe a également effectué une reconnaissance de 6 autres pertes plus à l'Est, dont certaines semblent prometteuses. Un puits (Tragadero 2) a été brièvement exploré sur > 200 m et il continue, mais présente une atmosphère confinée. La perte 5 semble également très prometteuse, avec un puits d'entrée de 5 m, non descendu.

2023 Expedition Members

Pete Talling (UK) - Expedition Leader - *(PT)*
José Antonio De Pomar Cáceres (Perú, ECA) – Expedition Co-Leader - *(TdPC)*
Gareth Davies (UK) - *(GD)*
Chris Densham (UK) - *(CD)*
Dominik Frohlich (Germany) - *(DF)*
Mike Futrell (USA) - *(MF)*
Rene Haemers (Netherlands) - *(RH)*
Martin Holroyd (UK) - *(MH)*
Andreas Klocker (Austria) - *(AK)*
Boaz Langford (Israel) - *(BL)*

With a large set of thanks to Liz Hidalgo (Perú - LH), Jean Loup Guyot (France - JLG), Jean-Yves Bigot (France - JYB) and Oliver Fabre (France - OF) for helping to organise many aspects of logistic that include local permissions, horses and local guides in Granada, group travel, and equipment storage.

We also extend a very large set of thanks to Dario Labajos Conilla, Lorenzo Gebol Gomez, and Rosa Auristela Labajos, and Gilberto Gebol Gomez and others from Granada, who organised logistics, and provided food and the horses that carried much of the equipment onto the high plateau.

Timeline (Chronogram) of 2023 Expedition

Overall dates: August 25th to September 20th in 2023

26 August: PT, GD, CD, DF, MF, RH, MH arrive in Lima from UK, EU and US. They then fly to Tarapoto, followed by a private minibus journey from Tarapoto to Chachapoyas (9-10 hrs). The Tarapoto flight was delayed by ~2.5 hours, so the team were unable to take a detour to see the Rio Negro resurgence at the base of the plateau.

27th August: TdPC arrives Chachapoyas. PT, TdPC and MH meet LH at her parent's house in Luya, and recover 200m of rope and other caving equipment from the tackle store, and buy fuel.

28th August: Team completes shopping for food and packing in Chachapoyas.

29 August: Main team travels via minibus (2 hrs) from Chachapoyas to Granada. AK arrives Chachapoyas airport, meets LH in Chachapoyas, and they arrive in the evening in Granada (and there is a festival in Granada).

30 August: Whole team walk in from Granada to the base camp for the caving area (Calamina Camp, also called Yana Cocha Camp by local people) in single long day, bypassing the Jacinto Camp using in 2022. The walk had taken two days in 2022.

31 August: MH, BL and TdPC go with Lorenzo and 2 horses to be shown Lorenzo's Right and Left Eye sinks – which is a long day over tough terrain, with an eventual return to Calamina base camp. Rest of team sorts gear at Calamina Camp, and PT shows GD, RH, DF and MF some of the entrances found in 2022 that are nearest the Calamina Camp. Lorenzo and Rosita cook for team at Calamina Camp.

1st September: Lorenzo and 2 horses, and whole team, help to carry equipment from camp Calamina to satellite camp for Group 1 at Tragadero 1 de Planura del Pico del Oro (2 hrs), which has good camping sites. PT, MF, GD, RH and DF look at Sinks 17 and 18 near to that camp on way back, but all are choked (although Sink 17 has a squeeze that might be capped). It is a very rainy day.

2nd September: Group 1: TdPC and BL go to Lorenzo's Right Eye (Sink I) and start rigging. MH, CD and AK descend 1km-wide mega-doline that was ~100m deep located SE of Tragadero 1 de Planura del Pico del Oro. Doline has tough vegetation and terrain, but no caves.

Group 2 [PT, MF, GD, RH and DF] explore small entrances found in 2022 near to Calamina Camp. Entrance 16-1 is explored down a 3m entrance climb, to a further short climb or pitch down - that will need a handline and thin caver (for getting back up), and this cave potentially continues. The cavers then locate the entrance Tragadero de Rayo Urmana, which was first found in 2022.

3rd September: Group 1: MH, BL, TdPC rig and survey Lorenzo's Right Eye (Sink 20). CD, AK rig Lorenzo's Left Eye.

Group 2: PT, RH and DF go to Tragadero de la Soledad (aka Bigger Sink) and survey/rig the first 3 short pitches in entrance series. GD and MF rig the initial pitches of Tragadero de Rayo Urmana.

4th September: Group 1: MH, CD, BL, TdPC and AK go back to Calamina Camp to resupply, and to discuss tactics with Group 2. BL reccies a mega-doline en route (P10). DF recovers 15 krabs to give to Group 1.

Group 2: PT, RH and DF rig down three more pitches in Tragadero de la Soledad, to where more horizontal passage starts. GD and MF rig and survey the impressive Tragadero de Rayo Urmana, but unfortunately to conclusion when it chokes.

5th September: Group 1: MH recovers MSR bottle from Calamina Camp, CD, BL, TdPC and AK have rest day.

Group 2: GD and RH rig and explore past the perched sump in Tragadero de la Soledad, and into the start of the main streamway. PT, DF and MF survey the entrance series to limit of exploration.

6th September: Group 1: MH, BL and TdPC have big day rigging in Lorenzo's Right Eye. CD and AK prospect in Lorenzo's sinks area – but all choked.

Group 2: Rest day for PT, GD, RH, MF, DF.

7th September: Group 1: MH, CD, AK, TdPC, BL have reconnaissance for resurgences in major valley to south of camp, proving there is no major resurgence in this valley. But very challenging terrain and vegetation.

Group 2: PT, MF, DF, RH and GD go for long walk to reconnoitre Sinks 2 to 6. Sink 2 is explored for ~200m by PT. Sink 3 is choked by a landslides, and Sink 4 is blind, But Sink 5 looks very good, but needs a rope for a 5m entrance pitch. Sink 6 is a narrow canyon full of vegetation, and hard to assess.

8th September: Group 1: CD and AK rig down Lorenzo's Left Eye. MH, TdPC and BL catch them up, with BL surveying.

Group 2: PT, MF, DF survey down main streamway in Tragadero de la Soledad, whilst GD and RH rig 2 small pitches ahead in streamway.

9th September: Group 1: CD, AK, TdPC, BL and MH rig final available 40m rope in Lorenzo's Left Eye, and then derig that cave, with ropes stored near the cave entrance.

Group 2: PT, RH, DF, GD survey Tragadero de la Soledad to reach huge Lamb and Fox Chamber. MF collects wood at Calamina Camp, as low on fuel, and team will need to cook on a fire to save fuel.

10th September: Group 1 all returns from Tragadero 1 de Planura del Pico del Oro Camp to Calamina Camp, and Group 2 come to TdPdO camp to assist with carry of equipment (there are no horses).

11th September: Much of team in Tragadero de la Soledad. PT and AK survey very large upstream passage from Lamb and Fox Chamber – which ends in huge collapse, albeit with one lead left. MF

and BL survey main downstream passage to 40m pitch (after BL goes back for Disto-X). GD, MH reg down to 40m pitch.

CD, RH and DF survey Sink 2, to a point in a u-bend with shingle slope, beyond where PT reached. They report bad air, although we will need sensors to determine the type (CO₂ or O₂) of bad air.

12th September: A rest day for whole team at Calamina Camp.

13th September: No horses arrive for DF, who waits at camp (but the horses come the next day). Rest of team explores and derigs Tragadero de la Soledad. MH and GD rig 40m pitch, and then short tape beyond. PT surveys down with them to sump at -205m, but with possible way over top, further back. TdPC has some light issues and waits at tape climb. CD and MF survey down 40m pitch. BL and RH take photos in the upper streamway of Tragadero de la Soledad. Some ropes left at entrance.

14th September: Horses arrive with Lorenzo and Rosita. DF, MH and CD walk down with 2 horses to Granada, and then taxi to Chachapoyas. A rest day at camp for others, packing and cleaning ropes.

15th September: Remainder of team walks from Camp Calamina to Granada (~7 hours) with lunch at the 7 lakes. Dinner in Granada, and then a mini van and taxi back from Granada to Chachapoyas.

16th September: PT, AK and TdPC do minor errands in Chacha (new generator cable). Others go to Kuelap cable car.

18th September: LH arrives with her mother on 8am bus into Chachapoyas. BL, MF, GD, TdPC, RH go with LH to Luya to take equipment back to the tackle store. PT, AK and TdPC stay in Chachapoyas. PT, GD, MF, AK, RH take night bus from Chachapoyas to Chiclayo. TdPC stays on for Soloco expedition with LH. BL and RH also stay on in Perú for a few days.

18-20th September: Rest of team travel stays in Lima, and travels back from Lima to UK, EU and US.

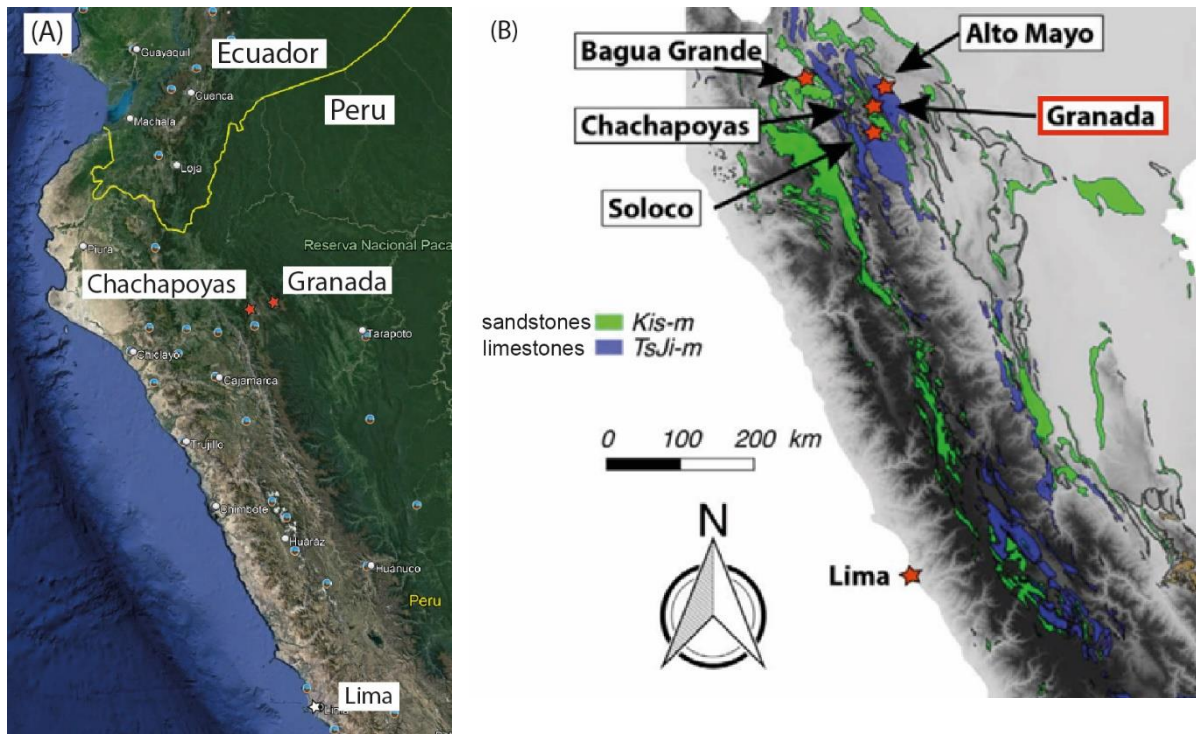


Figure 1. (A) Map showing location of Granada Plateau in northern Perú. **(B)** Geological map showing extend of limestone (blue) in northern Perú, with location of expedition area of Granada Plateau, as well as other major towns (e.g. Chachapoyas) and areas explored for caves in the past (e.g. Soloco). Figure from Baby (2020, 2023).



Figure 2. Map showing the expedition area on the Pico de Oro Plateau, above the village of Granada, to the east of Chachapoyas. Major caves, camps and the Rio Negro resurgence are also shown.

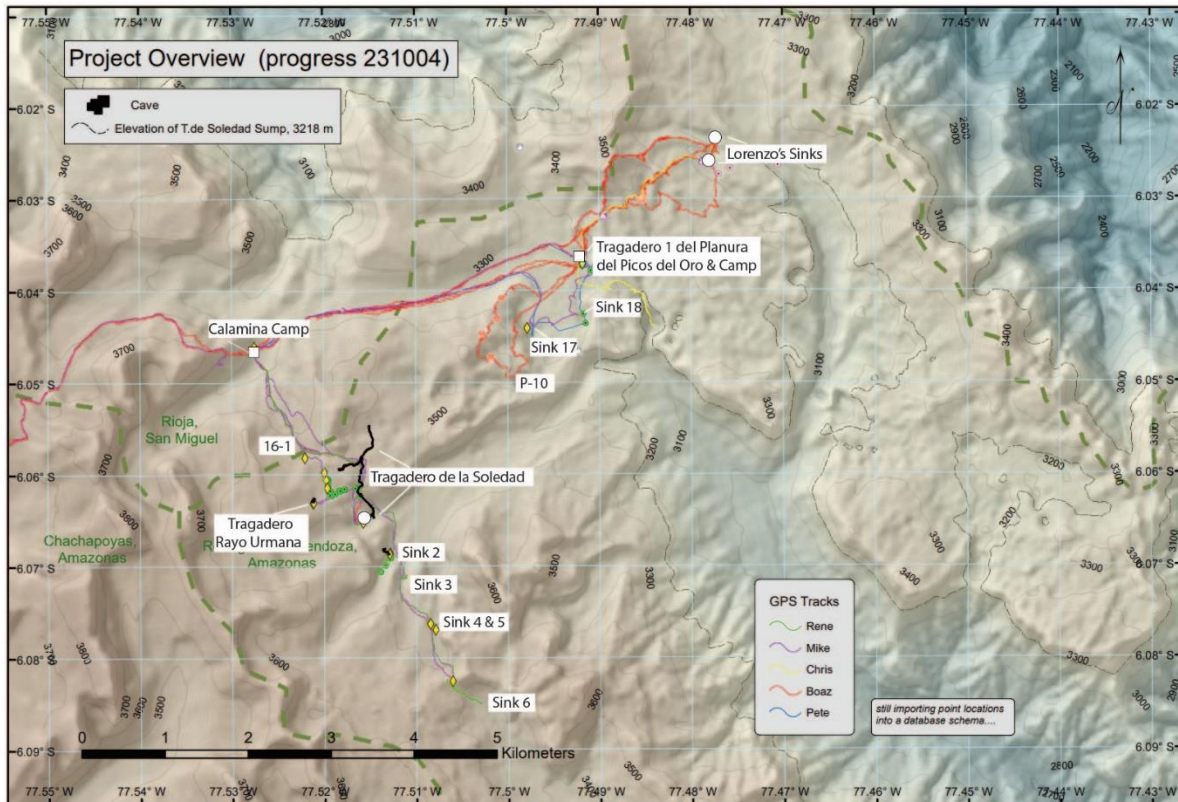


Figure 3. Detailed map by MF of the expedition area on the Pico del Oro Plateau, showing major caves or sinks, GPS tracks and camps. Survey of Tragadero de la Soledad is also shown as a thick black line.

Background to the Pico del Oro (Granada) Plateau

The expedition area was located in Northern Perú (Figs. 1 to 3). The area comprises a high (~3,300 to 3,700 m) plateau that is located to the east of the town of Granada, and bounded on its eastern side by a steep escarpment with over 2,500m of relief above the Moyobamba Plain (Fig. 4). The correct name for the plateau is the Pico del Oro Plateau, although the informal term ‘Granada Plateau’ was used in 2023 expedition planning. Granada is reached by a ~2 hour bus journey from the provincial capital of Chachapoyas (Fig. 2), which a hub for tourism within Northern Perú. Chachapoyas can be reached via bus from Jaen (4 hours), Tarapoto (9 hours), Chiclayo (10 hours), Lima (25 hours) or other major cities. We teamed up with local guides in Granada (Dario Labajos Conilla, Lorenzo Gebol Gomez, and Rosa Auristela Labajos, and Gilberto Gebol Gomez et al.), who provided horses to carry equipment, and we are very grateful for their hospitality in Granada.

The walk onto the plateau (Fig. 3) from Granada initially reaches the Siete Lagunas (Seven Lakes), which is being developed for tourism, with new huts built since 2022. The lakes are indeed very beautiful, and may make an attractive site for future tourism. The previously explored Tragadero de Maria Gondolan is located shortly before the Siete Lagunas (Fig. 3; Nord Perú 2018, 2019, 2022; Bigot, 2019). The walk continues over a col at 3,750 m that marks a major watershed, and descends to the Jacinto Camp used in the 2022 expedition (Figs. 2 & 3). We did not stay at Jacinto Camp in 2023, but carried on to the Calamina Camp, which is a further 2-3 hours (Figs. 2 & 3). This also simplified some logistics with horses. The Calamina Camp was used in 2022, and again formed the initial base camp in 2023.

The expedition then initially split into two groups of 5 cavers, to explore two separate parts of the Pico del Oro Plateau. The first group initially set up a satellite camp at the largest river sink on the

plateau, called the Tragadero 1 de Planura del Pico del Oro (Figs. 3 and 4; Nord Perú 2019, 2022; Klein et al., 2019). This allowed them to explore the rugged area of karst located east of that sink, including the vertical pitches of newly discovered Lorenzo's Right and Left Eye (Tragadero El Ojo Izquierdo y Derecho De Lorenzo). A second group of 5 cavers remained at Calamina Camp, and explored a series of major sinks to the south; Tragadero de la Soledad is the first of these sinks.

The terrain on the plateau can be challenging and very tussocky, or with pinnacle karst in some areas. The weather on the plateau is highly variable, often with rain in the late afternoons, but also with some very sunny days, or thunder-storms. In general, the ground was somewhat dryer than in 2022. Temperatures at camps sometime dips below zero, with a light frost at night. There is no light pollution, so the stars and milky way are especially vivid. The expedition saw deer, but spectacle bears have been observed rarely during expeditions in previous years.

Previous cave exploration: Three previous French-Peruvian caving expeditions has been to the karst areas around Granada, in 2018, 2019 and 2022 (Nord Perú 2018, 2019, 2022). This ECA-GSBM group have indeed been exploring for cave systems in Perú for over 20 years, with an excellent summary of that cave exploration history in Guyot (2019). We were very fortunate to have José Antonio De Pomar Cáceres from ECA on the 2023 expedition, although also very sad that Jean Yves Bigot could not join us as was originally planned. We also thank Liz Hidalgo (ECA), James Apaéstegui (ECA), Jean Loup Guyot (GSBM-ECA), and Oliver Fabre (ECA), as well as Dario Labajos Conilla, Lorenzo Gebol Gomez, and Rosa Auristela Labajos, and Gilberto Gebol Gomez and others from Granada, for helping us to organise the 2023 expedition. Information on the previous expeditions across Perú is available at www.cuevasdel Perú.org, which is an incredibly detailed resource for caving in South America.

The initial 2018 ECA-GSBM expedition was linked to a karst conference in Chachapoyas, and was used to explore the intriguing Tragadero de Maria Gondolan (Nord Perú, 2018). Then, in 2019, a camp was set up on the high plateau to explore the Tragadero 1 de Planura del Pico del Oro (Nord Perú, 2019), and adjacent sinks (e.g. Sinks 17 and 18 that were also visited in 2023). An expedition in 2022 then found the entrances to Tragadero de la Soledad and Tragadero Rayo Urmana, and confirmed the excellent potential of the area (Nord Perú, 2022). These expeditions also confirmed the challenging nature of the terrain, especially beyond Tragadero 1 de Planura del Pico del Oro, as was indeed also the strong experience of the 2023 team. The nature of the terrain meant that a larger team (with more horses) was needed in 2023, with self-sufficient satellite camps.

Geology and Hydrology of the Pico del Oro Plateau: The allure of the Pico del Oro is partly because of its large relief above the very large resurgence of the Rio Negro (Fig. 4 and 5; Baby, 2020, 2023). Indeed, there is up to 2,685 m of relief between the Rio Negro resurgence at 865 m, and cave entrances such as Tragadero Rayo Urmana at 3,550 m, Tragadero de la Soledad at 3,420 m, and Lorenzo's Sinks at 3,290 m (Fig. 5). This resurgence has an average flow rate of $\sim 24 \text{ m}^3/\text{s}$, with much higher flow (up to $35 \text{ m}^3/\text{s}$) in floods (Grandjouan et al., 2017). Moreover, the water in this resurgence is also notably colder than other main resurgences along the mountain front, suggesting quick through-flow times, and its large discharge suggests a large underground catchment (Grandjouan et al., 2017). Analysis of the magnitude of the discharge is also consistent with a drainage area including the Pico de Oro (Grandjouan et al., 2017). It is possible that the major river-sinks on the high plateau drain to an as yet unknown resurgence located in the very densely forested area on the steep escarpment down to the plain, where satellite images cannot penetrate. But if these river sinks drain to the Rio Negro resurgence, the resulting cave system could exceed the depth of the current known deepest cave (i.e. 2,210 m). Moreover, such a cave system would have a remarkably long horizontal separation of $\sim 23 \text{ km}$ to Tragadero 1 de Planura del Pico del Oro, or even 28 km if the cave system includes the Tragadero de la Soledad streamways. The furthest known point from a cave entrance is currently about $\sim 12\text{-}15 \text{ km}$, so this distance is also world class.

An excellent and detailed summary of the geology and hydrology of the Pico del Oro Plateau is provided by Baby (2023), setting out this world-class potential for deep caves (Figs 4 and 5; also see Baby et al., 2020; and Bigot et al., 2018). A brief summary of these previous publications follows (Figs 4 and 5), together with information from geological maps downloaded by MF from the outstanding Peruvian Geological Survey website (Figs 6 and 7).

The stratigraphy of the Pico de Oro Plateau includes a series of Cretaceous-to-Jurassic sandstone units, which form resistant cuervas (ridge-lines) along the massif's main crest (K_{i-o} and J_{s-s} units in Fig. 6). These sandstones and underlying mudstone layers dip westwards, back towards Granada (Fig. 6). Underneath the sandstones and mudstones are a series of Jurassic units that contain thick limestone intervals (e.g. J_{i-a} and J_{i-c} in Fig. 6). These limestone rich units are underlain by Triassic units (T_{s-ch}) which are described contradictorily as either as limestone-rich (1:50,000 geology maps) or sandstone and mudstone rich (1:100,000 geology maps). But structural cross sections extending from river sinks on the Pico de Oro Plateau and to Rio Negro may suggest they are connected (Fig. 5).

Only one resurgence has been found actually on the high Pico de Oro Plateau, and it occurs at the far southern end of the line of sinks extending south and east from Calamina Camp (labelled 'main resurgence' on Fig. 7). However, this resurgence is higher than the sink at Tragadero 1 de Planura del Pico del Oro, or indeed the lowest surveys points in Lorenzo's Right and Left Eye Caves, and it cannot thus contain the water from these major river sinks. Originally, it was hypothesised during 2023 expedition planning that the water from Tragadero de la Soledad, and maybe all 12 other sinks along a SE-NW line (Figs. 3 and 7), drained to this 'main resurgence'. But this now known not to be the case, as both streamways in Tragadero de la Soledad head away from this resurgence (Fig. 7), towards Tragadero 1 de Planura del Pico del Oro, Lorenzo's Sinks, and the Rio Negro resurgence.

The elevation above sea-level of the sump (at 3,218 m) in Tragadero de la Soledad system is also marked on Figure 3 for reference, and this water must also drain to a lower resurgence. It is also not clear where the water originates in that largest of the two streamways (Pisco and Codeine stream) in Tragadero de la Soledad, as this streamway heads NW back towards Granada (Fig. 7). It may yet collect water from along the line of sinks (i.e. sinks 2 to 6), which must then double back to flow first north and then south, but is unlikely to be connect to Tragadero de Maria Gondolan that likely resurge nearer to Granada (Fig. 3). Understanding the origin of water in the Pisco and Codeine streamway is intriguing. It is also important to test the hypothesis that the main stream in Tragadero de la Soledad connects (beyond its sump) to water from Tragadero 1 de Planura del Pico del Oro, Sinks 17, and 18, possibly as well as Lorenzo's Right and Left Eyes; and the combined water then heads towards the Rio Negro Resurgence. This hypothesis may yet be thwarted by thick mudstone bands, as seen in caves explored in 2023, or by a paucity of limestone in the Triassic (e.g. T_{s-ch}) units.

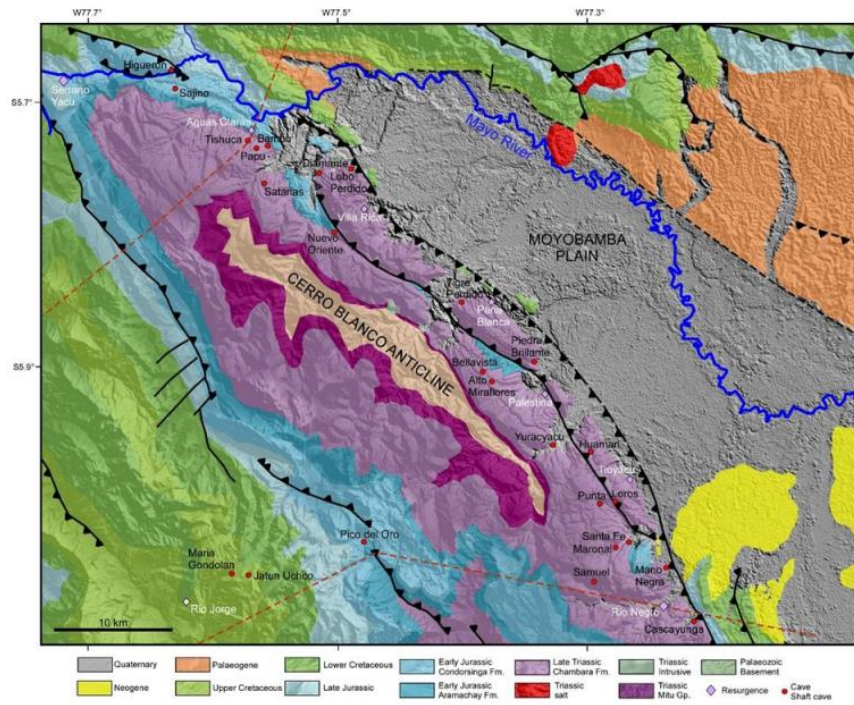


Figure 4: Geological map of the Cerro Blanco massif, showing the location of major caves and resurgences, which is reproduced from Baby et al. (2023). Pico del Oro label denotes Tragadero 1 de la Planura de Pico del Oro; the red dotted line shows the location of the cross section in Figure 5.

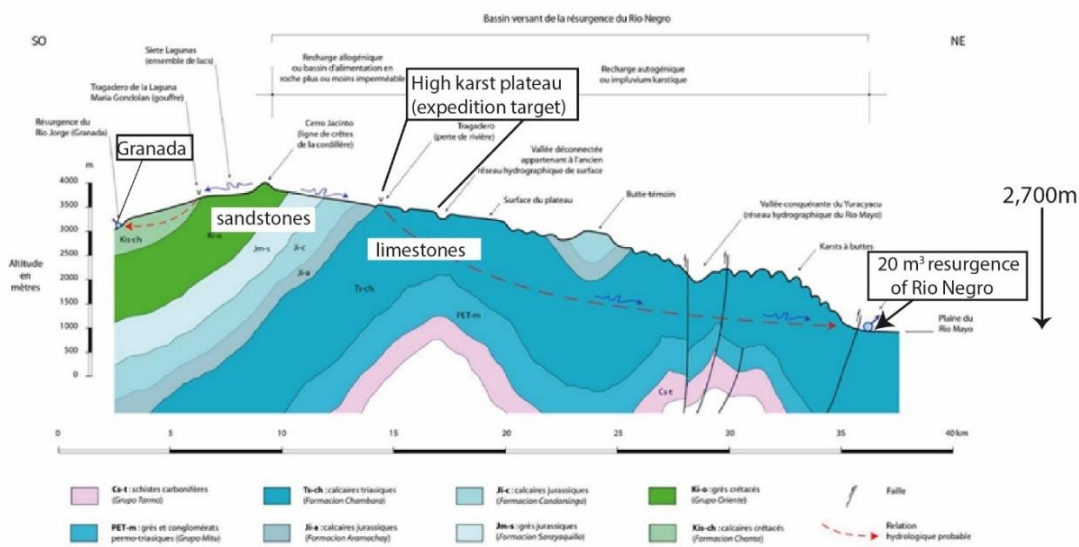
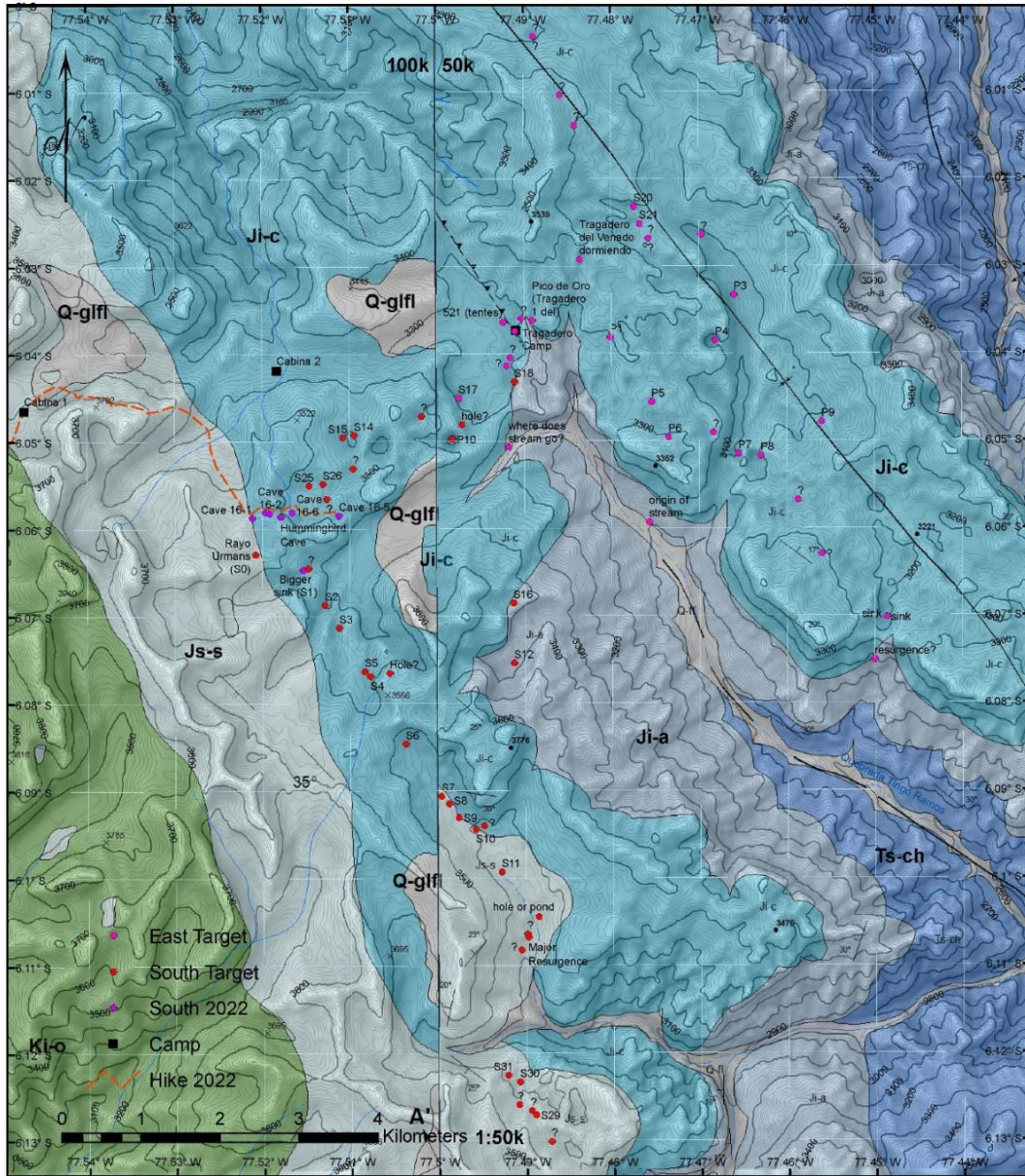


Figure 5. Geological cross section from Granada (left) to the massive resurgence of the Rio Negro (right). From Bigot (2019), and see Baby et al. (2020, 2023). Rivers flowing across sandstones sink when they reach limestones (in blue). The limestone units have a vertical elevation change of up to 2,700m, which exceed the depth of the deepest known cave. Dye test have not been performed, but it is hypothesised that rivers sinking on the high plateau drain to Rio Negro (red dotted line).



Grupo Pucará	100k	Formación Sarayaquillo	Js-s	Areniscas rojizas moradas de grano fino a grueso, microconglomerádica, presenta intercalaciones de limolitas y arcillas	Js-s 100k map: Reddish purple fine to coarse grained sandstones, microconglomeradic, presents intercalations of siltstones and clays.
		Formación Condorsinga	Ji-c	Calizas con delgados niveles de areniscas, con algunas intercalaciones de cineritas, margas y con ocasional contenido de chert	50k map: Fine-grained to medium reddish-brown sandstones and are cross-bedded with levels of red shales, green shales and red siltstones.
		Formación Aramachay	Ji-a	Calizas arenosas negras, bituminosas con olor fétido, capas delgadas, intercaladas con areniscas calcáreas parduzcas	Ji-c 100k map: Limestone with thin levels of sandstone, with some intercalations of cineritas, marls and with occasional content of chert.
		Formación Chambará	Ts-ch	Areniscas grises con contenido de materia orgánica, intercalada con limoarcillitas marrones a pardas y arcillosas	50k map: Massive whitish gray limestone in 20 to 60 cm strata.
Grupo Mitu			PET-m	Andesitas porfíricas de naturaleza plagioclásica	Ji-a 100k map: Black sandy limestone, bituminous with fetid smell, thin layers, interspersed with calcareous sandstones brownish.
Grupo Pucará	50k	Formación Condorsinga	Ji-c	Calizas masivas de color gris blanquesina en estratos de 20 a 60 cm.	50k map: Yellowish gray limestone, interspersed with brownish siltstones dark with ammonites.
		Formación Aramachay	Ji-a	Caliza gris amarillentas, intercaladas con limoarcillitas de color marrón oscuro con amonites.	Ts-ch 100k map: Gray sandstones with organic matter content, interspersed with brown to brown siltstones and clayey.
		Formación Chambará	Ts-ch	Calizas estratificadas masivas en estratos de 1 a 3 m. de coloración gris oscura.	50k map: Massive stratified limestone in layers of 1 to 3 m. of gray coloring dark.

Figure 6. Geological map that combines information from 1:100,000 scale (left) and 1:50,000 scale geological maps, downloaded from the excellent Peruvian Geological Survey website.

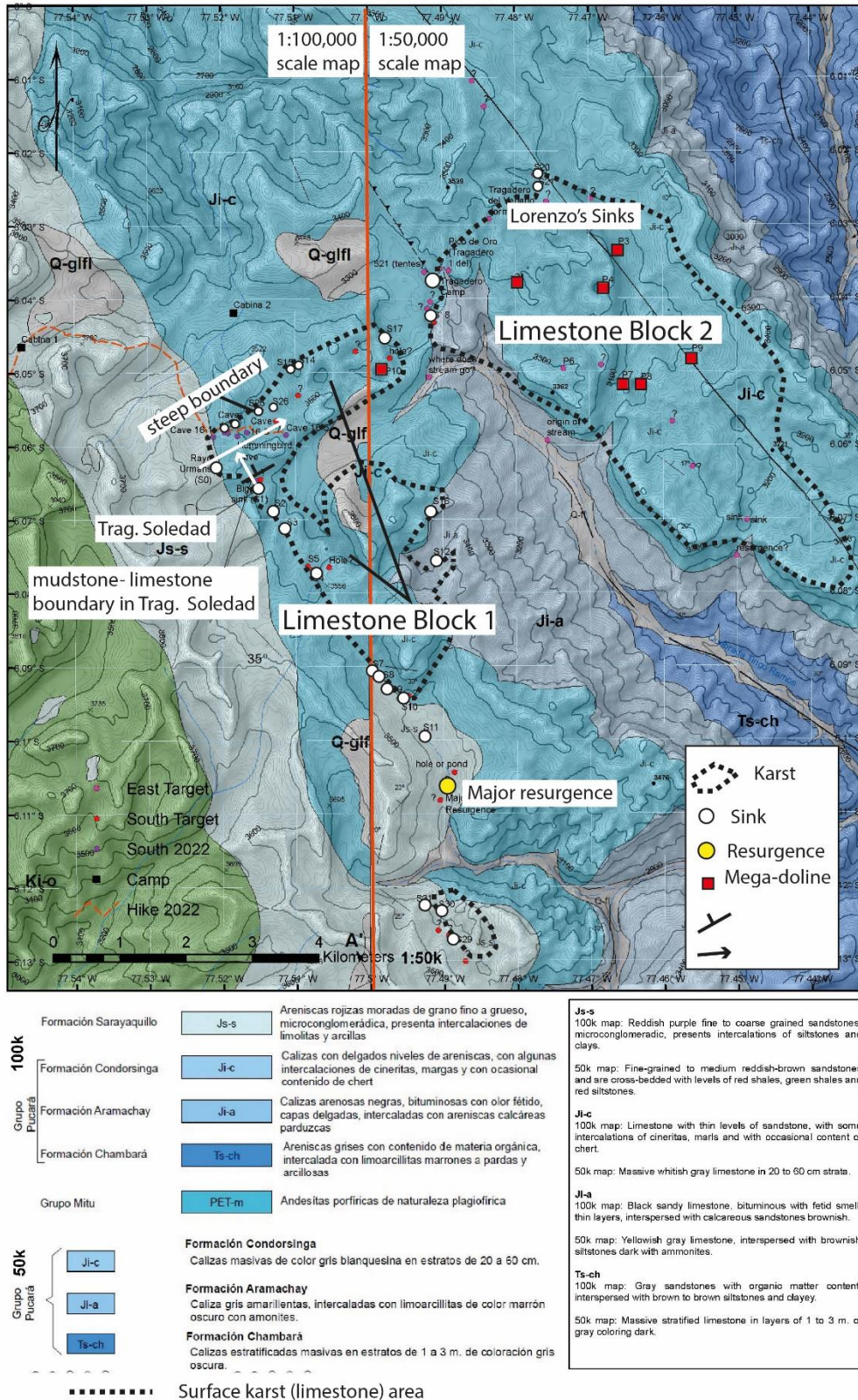


Figure 7. Geological map (as in Figure 6) with superimposed information from field observations in the 2023 expedition, including areas of surface limestone karst and other geological observations.

Caves Explored in 2023

The first set of caves lie to the south and west of the Calamina Camp (Fig. 3). Currently, the longest and deepest cave that was explored in 2023 is Tragadero de la Soledad, which is reached by a ~90 minute walk from Calamina Camp. The adjacent Tragadero 2 (Sink 2) was also explored for a ~200 meters. Two caves found in 2022 were also explored further (Staccioli, 2023). Tragadero Rayo Urmana is a large entrance that ends at a choke, whilst Cave 16-1 was explored a few meters further, and is ongoing.

Tragadero de la Soledad (Solitude Sink - previously called Bigger Sink in Nord Perú, 2022):

-6.06477°S -77.51528°W; Surveyed length = 2,345m; depth = 205 m, entrance elevation = 3420m

The small entrance to this cave is located at the base of a cliff, a few meters above where a major river sinks, at the end of a deep gorge cut by the river (Fig. 8). The entrance was discovered in 2022 (Talling, 2023), by PT during one of the few days he was not ill with food poisoning, on a solo trip away from Calamina Camp (hence the name). The short entrance tube quickly led to a chamber, beyond which was a 7m pitch that was left undescended in 2022.



Figure 8. The small entrance to Tragadero de la Soledad, with the large rock moved to find entrance.

This 7m pitch was descended in 2023, and it rapidly led to a series of short pitches (~3m, 5m, 11m, 12m, and 12m; Fog that cork-screws down near-vertically to descend a total height drop of ~65m (Figs. 9 and 10). At the end of the pitches is a linear chamber, and both the chamber and pitches have numerous smooth river cobbles indicating floodwater overflow. A short down-climb and pitch (6m) then leads to more horizontal dry cave, that has well-washed walls and cobbles in places (Fig. 11), to a sump. A short climb over the sump quickly leads to further horizontal passage, and a short crawl on cobbles with a very strong draft. Interestingly, this draft sometimes reverse or wanes, on consecutive days. This crawl emerges at a junction with a larger active streamway, whose upstream continuation rapidly lowers and sumps. A dry and well-decorated upstream branch also heads SE

from the junction for about 30m, until there is a choke. A small caver (ideally with a crow-bar or caps) may make more progress in this interesting direction, with a small stream seen in the floor.

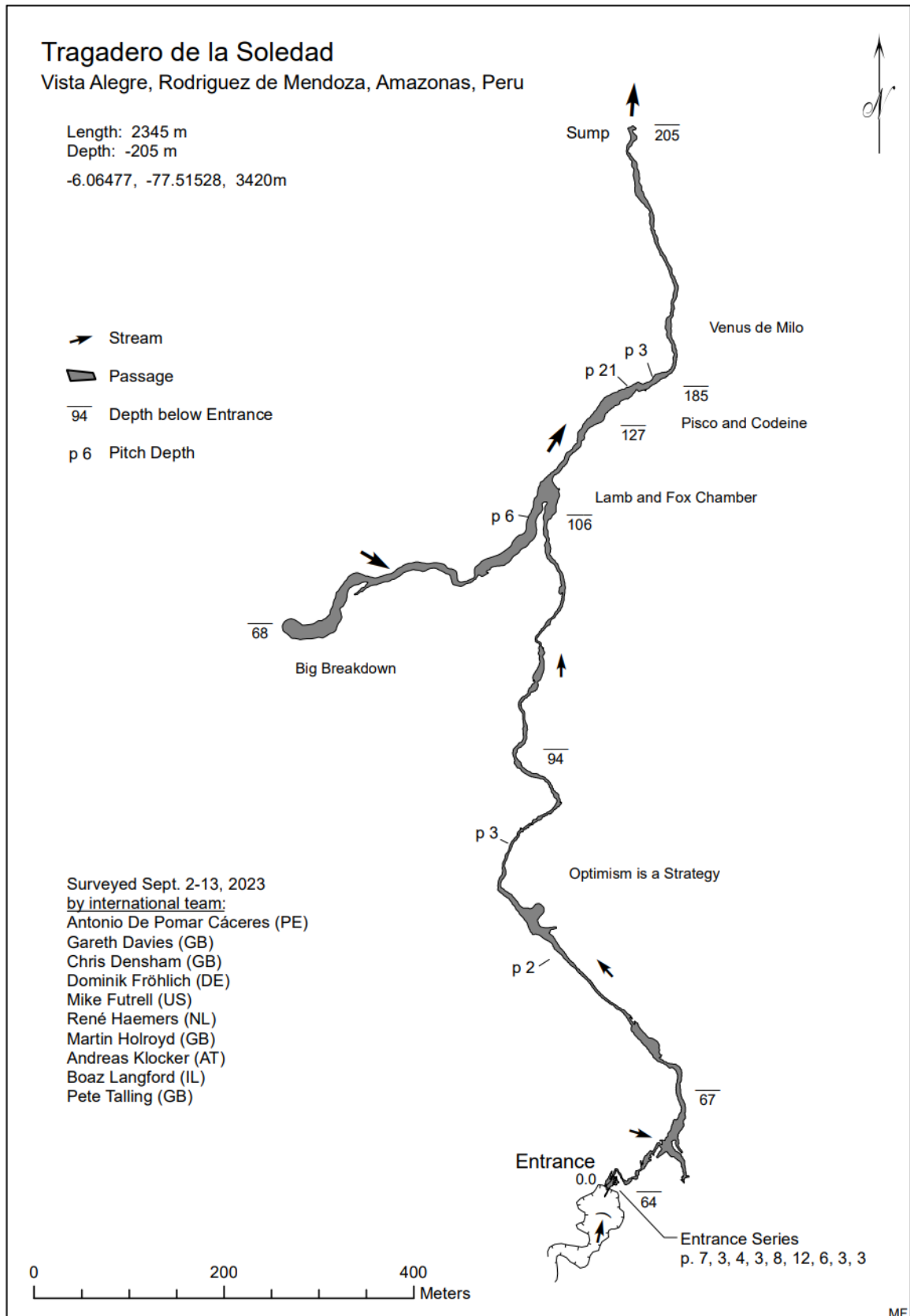


Figure 9. Survey of Tragadero de la Soledad (drawn by MF), including the upper (Optimism is a strategy) and lower (Pisco and Codeine) streamways

Tragadero de la Soledad - Rigging Topo

(note that rope lengths are approximate)

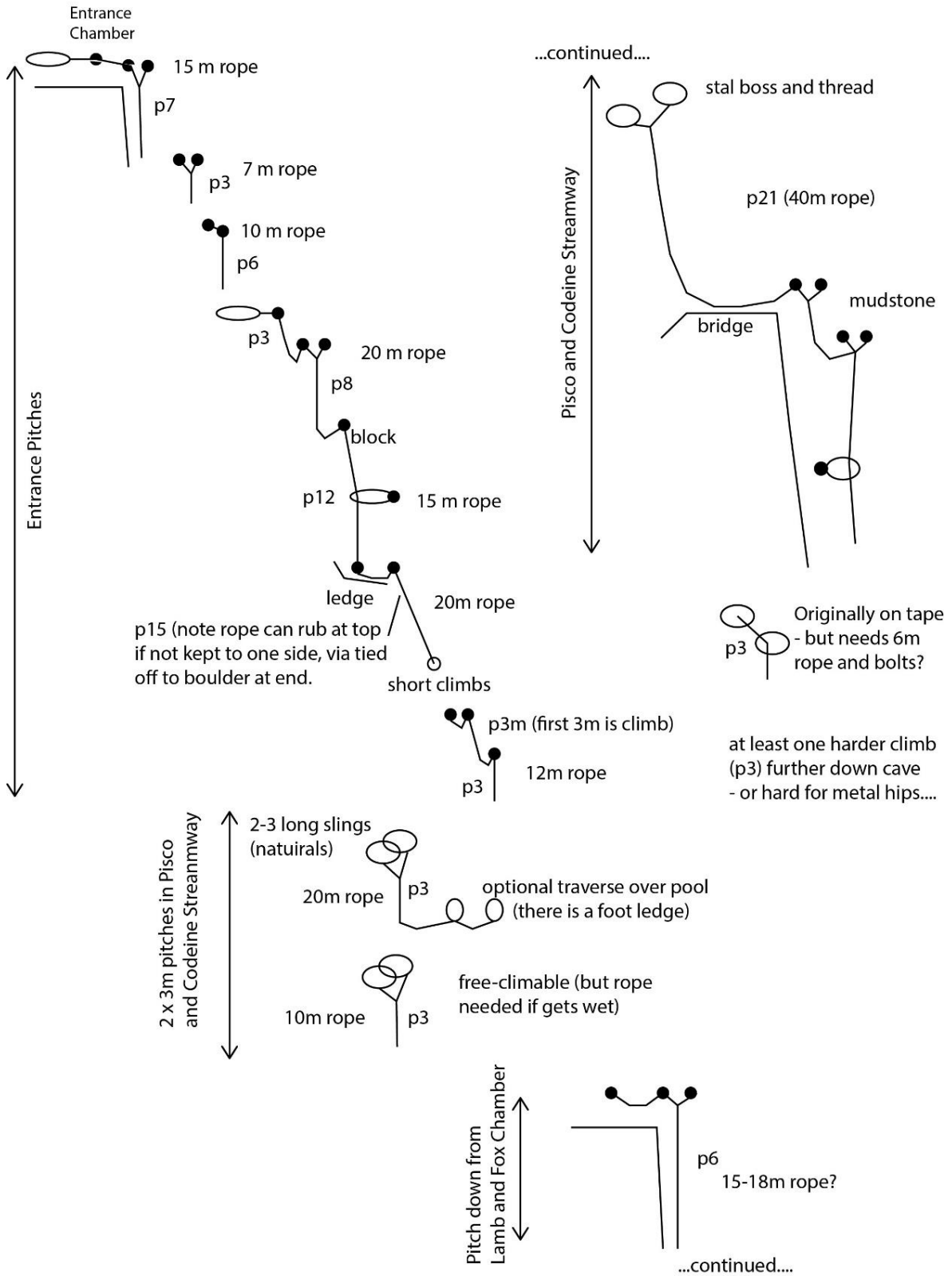


Figure 10. Rigging guide to Tragadero de la Soledad, note that rope lengths are approximate.



Figure 11. Passage with cobbles, upstream from the start of the Optimism is a Strategy streamway, with Mike Futrell in one of the few crawls. Photo by Boaz Langford.

The downstream continuation of this major (~ 8-10m wide) streamway (called Optimism is a Strategy - El Optimismo es una Estrategia) is exceptionally well decorated, and possibly as pretty as any streamway seen worldwide by the expedition members (Figs. 12-14) It is mainly easy walking-sized passage, with water up to one's boots, that slaloms between large stalactites hanging from the roof. In general, the passage follows the boundary between limestone and underlying mudstone, which dips at ~3 degrees to the north-north-west (Fig. 7). The passage also involves various small obstacles, including two 3m pitches (potentially free climbable, but rope may be essential if water level rises) that were rigged mainly off naturals, and a short canal that can be waded or easily traversed. After ~1.2 km, a short climb over blocks leads up to a very large chamber.



Figure 12. Straws in the upper Optimism is a Strategy streamway (photo by Boaz Langford).



Figure 13. Rene admiring some more unusual formations within the Optimism is a Strategy streamway within Tragadero de la Soledad (Photo from Boaz Langford).

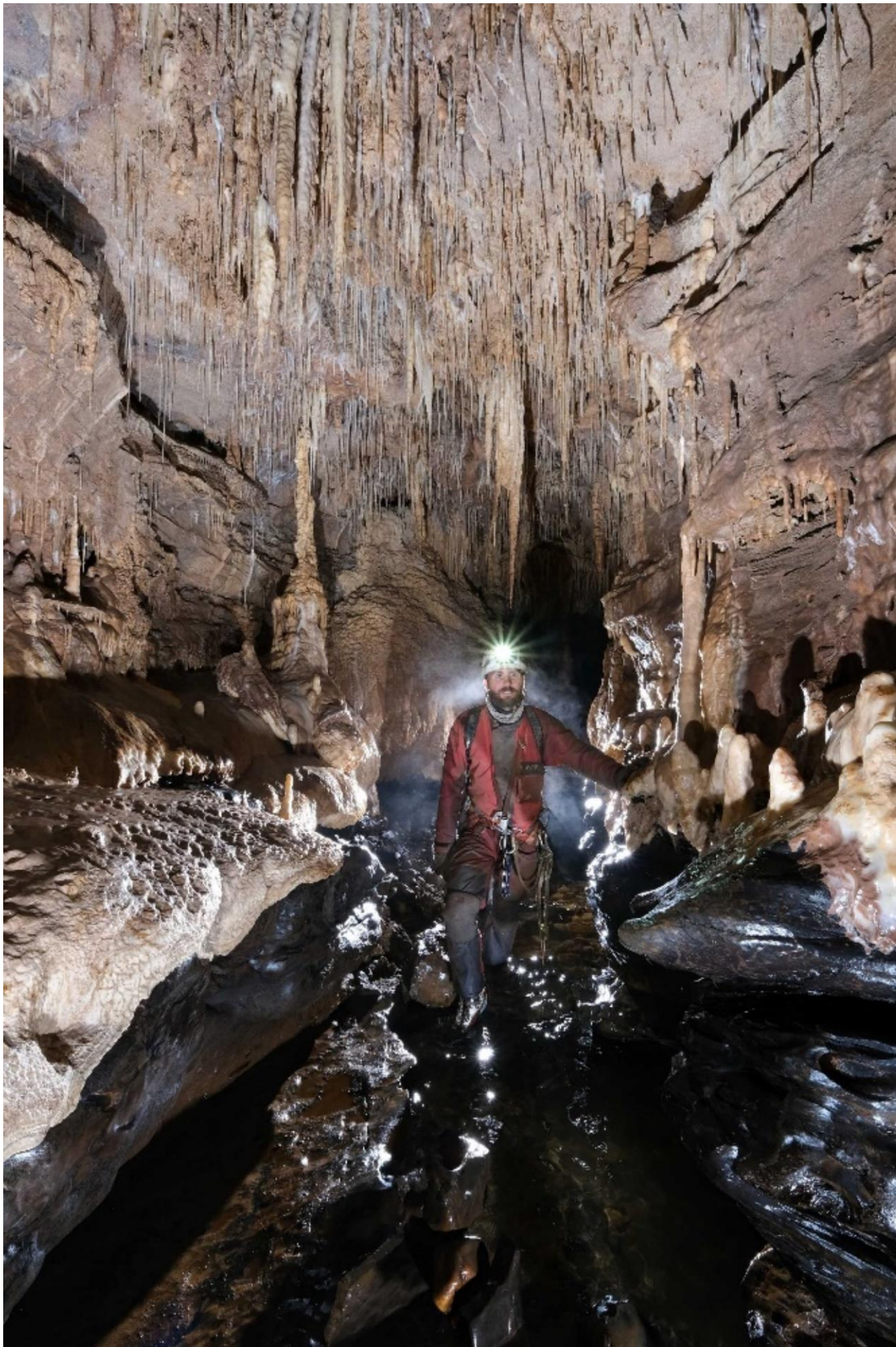


Figure 14. Optimism is a Strategy streamway within Tragadero de la Soledad, showing typical quality of formations, and depth of water. Photo by Boaz Langford.



Figure 15. Trench with deep water in Optimism is a Strategy Streamway, which can also be traversed. Photo by Boaz Langford.

This large and block-filled chamber (Lamb and Fox Chamber - Cámara del Cordero y el Zorro) is about 25-30m in diameter, and it marks the junction with a second even larger streamway (Pisco and Codeine Streamway - Corriente de Pisco y Codeína). The upstream branch of this larger stream way continues for ~400m as large passage to a very large (25 x 25m) chamber formed by an extensive collapse (Nervous Breakdown- Crisis Nerviosa). A very loose climb at the end of the main collapse leads via a short crawl to another low chamber, which is choked at its end. It may be worth digging with a crow-bar, but there is no strong draft in that final choked crawl. About 100m before the final climb up, there is a small passage on the left wall that descends a few meters to a low streamway, which continues with deep water – but which has not been fully pushed to a final conclusion. The main stream itself disappears under boulders in an upstream direction, with no viable air space.

The downstream continuation of the Pisco and Codeine streamway is reached by a ~6m pitch down from Lamb and Fox Chamber. This is soon followed by a second ~40 m (15 x 20 m) pitch, in two parts, separated by a walk or crawl along a short intervening ridge. This larger streamway has been carved deeply into the mudstones, and is even more exquisitely decorated than the previous Optimism is a Strategy streamway. There are particularly fine formations in the Venus de Milo chamber, but fine formations are widespread. After a climb over a boulder-pile, and climb down next to a waterfall, there is a short (3m) pitch, which was descended and ascended on a tape line by the original explorers in 2023, but a small rope is needed. There is then a climb over a boulder choke and various other fairly tricky small climbs, often on slippery mudstone. This lower streamway continues for several hundred meters to a sump, at a depth of -205m below the entrance. However, there is a strong draft further back from the sump, and surveys legs of up to 30m can be shot into an overlaying large space. The best place to climb up is over blocks, and not the climb immediately before the sump, but this climb will need a rope and some bolting – to see if there is a continuation.



Figure 16. Pitch down from Lamb and Fox chamber into the lower Pisco and Codeine streamway in Tragadero de la Soledad (Photo by Martin Holroyd).



Figure 17. Part of the well decorated Venus de Milo chamber within the lower Pisco and Codeine streamway in Tragadero de la Soledad. Photo by Mike Futrell.

Tragadero Rayo Urmana:

-6.0631°S -77.5211°W; Surveyed length = 192; depth = 65 m, entrance elevation = 3,528m

This impressive entrance lies at the end of a small stream, which sinks along the north-western boundary of limestone units, about 650m to the north-west of Tragadero de la Soledad. It was originally found in 2022 (Nord Perú, 2022; Staccioli, 2023). A small stream ran down a narrow gorge of loose boulders (requiring protection) before reaching an open air chamber with a floor of breakdown boulders leading to two more pitches. At the bottom of the final pitch a large room was entered with no draft or noise. A steep mud slope ascending on the left finished at the bottom of an aven. Downstream a large walking passage soon ended with a short crawl under the right hand wall, and ended in a mud breakdown pool with little prospect of a continuation.



Figure 18. Tragadero de Rayo Urmana, which entrance (top) and internal shaft (lower). Photos by Gareth Davies

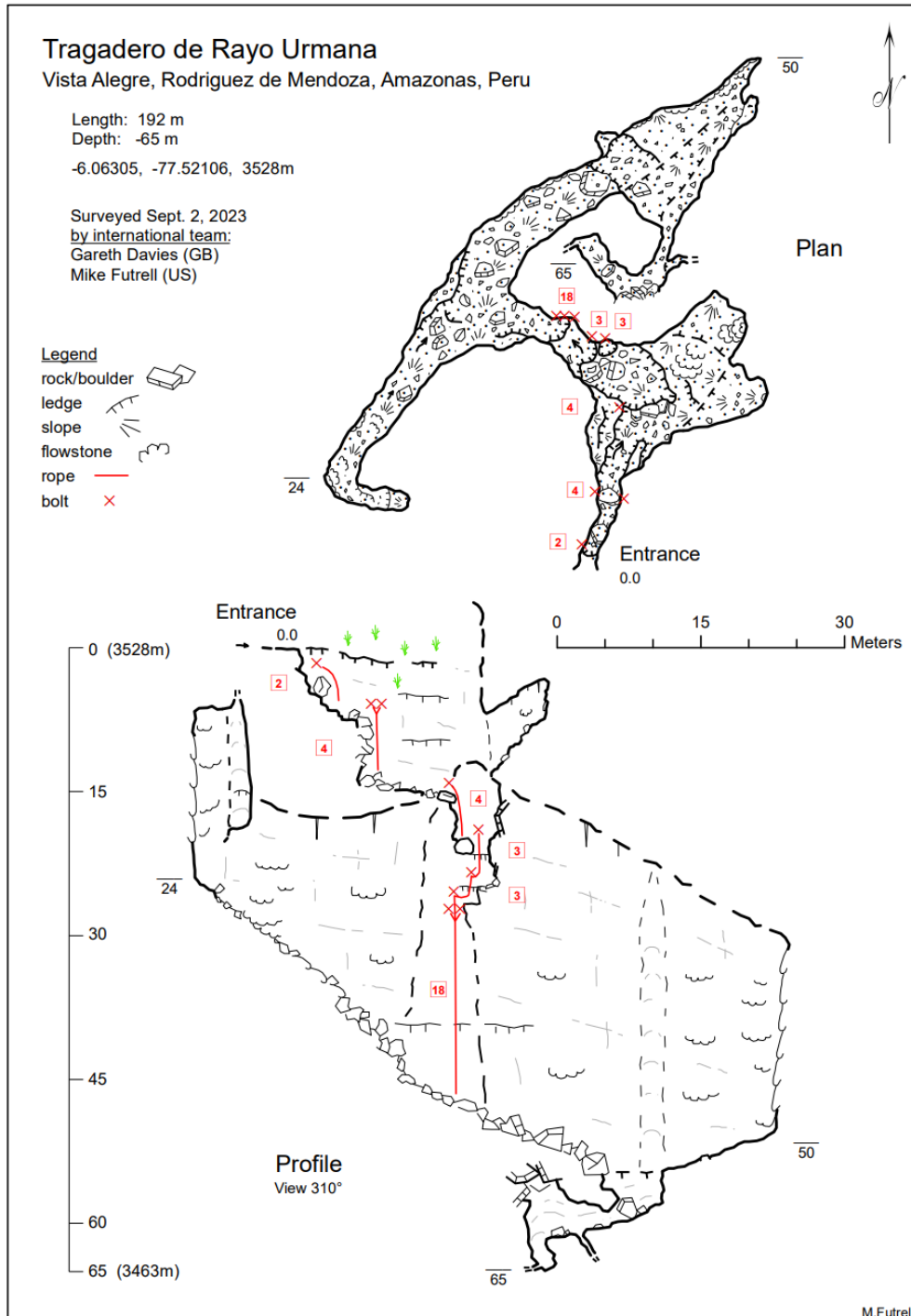


Figure 19. Survey of Tragadero de Rayo Urmana by MF.

Entrance 16-1: -6.0587°S -77.5211°W; Length = ~12 m; depth = ~12 m, entrance elevation = 3,524m

This is the nearest entrance to Calamina Camp, at a small sink at the edge of the limestone. The short (2m) entrance climb was descended to a small chamber, which led to a further small (< 5m) climb or pitch down. This small climb or pitch will need a short (<10m) handline, especially for larger cavers on the way back up. It is undescended and open, and with draft, albeit small and tight. The entrance is well placed beyond the upstream choke of Tragadero de la Soledad. The nearby Hummingbird Cave (see 2022 report) is also open, and may pay dividends for further exploration.

Sink 2: -6.0687°S -77.5128°W ; Length = > 195 m; depth = 16 m, entrance elevation = 3,408m

This large river sink lies about 1 km beyond Tragadero de la Soledad, also the end of a narrow canyon cut by the stream, although the sink and canyon are not quite as big as Tragadero de la Soledad sink. The cave mainly comprises walking size passage, which was dry in 2023. But it has a floor of rounded cobbles, and obviously takes a lot of water during major floods.

The survey ends where the survey team encountered bad air, just beyond a cobble floored u-bend, where it may be advisable to station a caver to make sure cobbles do not block the u-bend. However, it may be worth a further check of this open and continuing passage, with an oxygen or CO₂ meter, and bad air not reported during an initial exploration trip, albeit not beyond the u-bend.

Tragadero 2

Vista Alegre, Rodriguez de Mendoza, Amazonas, Peru.
 6.0687° South, 77.5128° West; Elevation 3,408m

Explored by P. Talling, C. Densham, R. Haemers, & D. Frohlich.
Surveyed by C. Densham R.Haemers, & D. Frohlich. Drawn by P. Talling.
September 2023. Vertical Range 16m, Length >195m

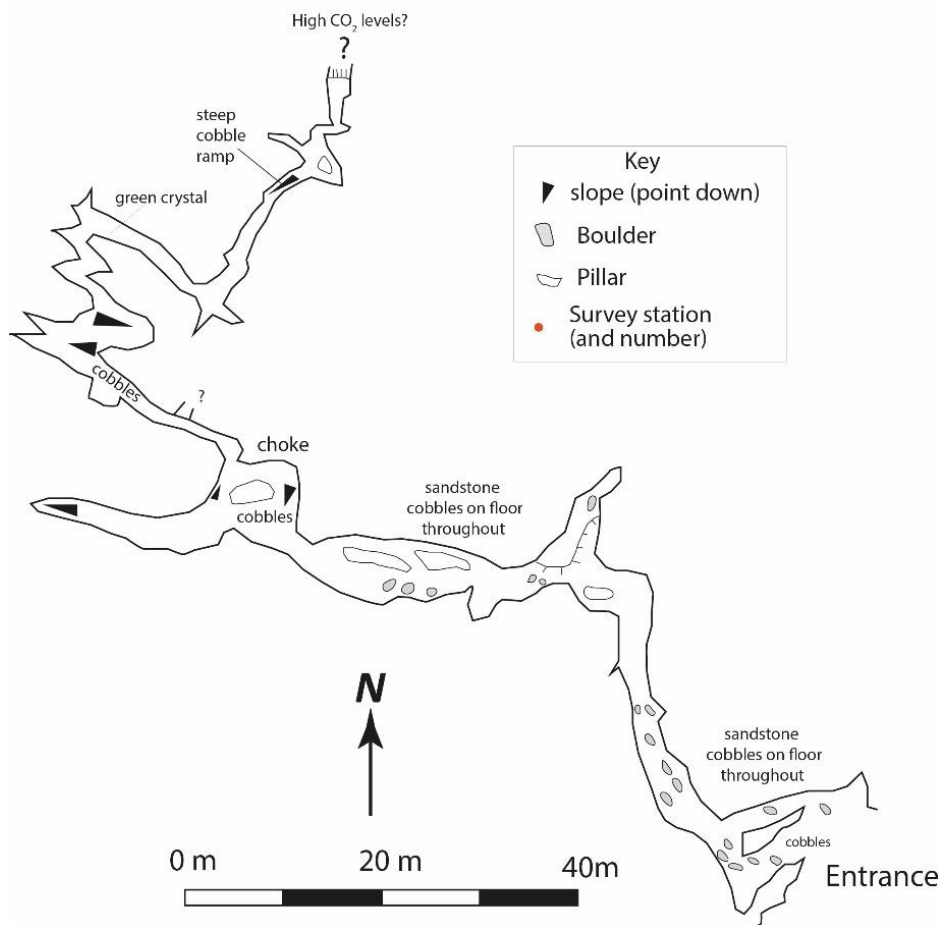


Figure 20. Survey of Tragadero 2 that has bad air at the end of the surveyed length.

Tragaderos 3-to-6 (Sinks 3-to-6): See coordinates list and Figure 3.

A single trip without ropes or SRT kits was made to a series of major sinks that extend to the southeast from Sink 2 and Tragadero de la Soledad.

- Sink 3 is large but totally choked, probably by a landslide from the overlying slope.
- Sink 4 is a doline rather than a true river sink, and is adjacent to Sink 5. But Sink 4 is choked.
- However, Sink 5 looks very good. It has a short (3m) entrance pitch that needs bolting and a suitable rope, but a significant stream passage can be seen to continue.
- Sink 6 lies over the watershed, where a stream forms a length and heavily vegetated canyon. It is tricky to climb into the canyon without an oversuit, and this site may need rope and bolts. It is harder to assess than Sink 5, but could be a promising site for further exploration.

Eastern Area (Group 1): The next two major cave entrances lie several kilometers beyond Tragadero 1 de la Planura del Pico del Oro (Fig. 3), 1.5 to 2.5 hours walk across very challenging terrain on the karst plateau (see map for best track – Fig. 3). The entrances were kindly shown to us by Lorenzo Gebol Gomez, and lie adjacent to one another, on either side of a nose-like ridge (hence the initial names). Both caves are significant river sinks, although the shafts had no active stream on most days in 2023. But Lorenzo’s Right Eye had a significant stream after prolonged rain (i.e. not just afternoon shower), with associated risks to rigging in the shaft. Both shaft series are thus serious propositions, which need careful rigging due to potential for flooding.



Figure 21. Looking back at Tragadero 1 de la Planura del Pico del Oro the from the initial part of the walk to Lorenzo’s Sinks. Photo by Boaz Langford.



Figure 22. Panorama over the karst area to the east of Tragadero 1 de la Planura del Pico del Oro, towards the edge of the plateau. Photo by Boaz Langford.

Tragadero del Ojo Derecho de Lorenzo (Lorenzo’s Right Eye):

-6.0232°S -77.4774°W; Length > 163 m; depth > 158 m, entrance elevation = 3,290m

The ‘Right Eye’ is the slightly larger entrance of the two sinks that the team were shown by our guide Lorenzo.

To enter the pot requires a very steep grassy slope, then scrambling down small cascades to reach the entrance. Here the way one steepens with successive climbs and pitches with very little horizontal development. The first trip was in dry conditions with no water flowing, and this enabled the initial pitches to be dropped quickly, until the rope ran out at the head of a deep shaft. The smooth walls and flood debris suggested this system takes a lot of water at times. Indeed, on our return following heavy rain, the stream was flowing. This made some pitches almost impassable and it was very cold underground. Additional bolts and deviations were added to keep clear the powerful waterfalls. Initially the rock is very solid. However, the final two rigged pitches were into much looser, fractured rock thereby limiting the bolt placements.

The limited amount of ropes and metal work available in 2023 were soon used up, at the head of an undescended 15m drop. The way on continues around the corner to another drop, which was confirmed by throwing stones. The cave was surveyed to the undescended pitch, and several photos taken, before this cave was stripped of ropes and hangers for use in Lorenzo’s Left Eye.

Both sinks are located over 2 hours from the Tragadero camp site over rough terrain and no distinct path. Further exploration will be aided by utilising the ‘Scottish camp’ which is close to both caves.

Tragadero El Ojo Derecho De Lorenzo

Vista Alegre, Rodriguez de Mendoza, Amazonas, Peru.
 6.0232° South, 77.4774° West; Elevation 3,290m

Explored by J. A. De Pomar Ceceres, C. Densham, M. Holroyd,
 A. Klocker & B. Langford. Surveyed by B. Langford.
 September 2023. Vertical Range >158m, Length >163m

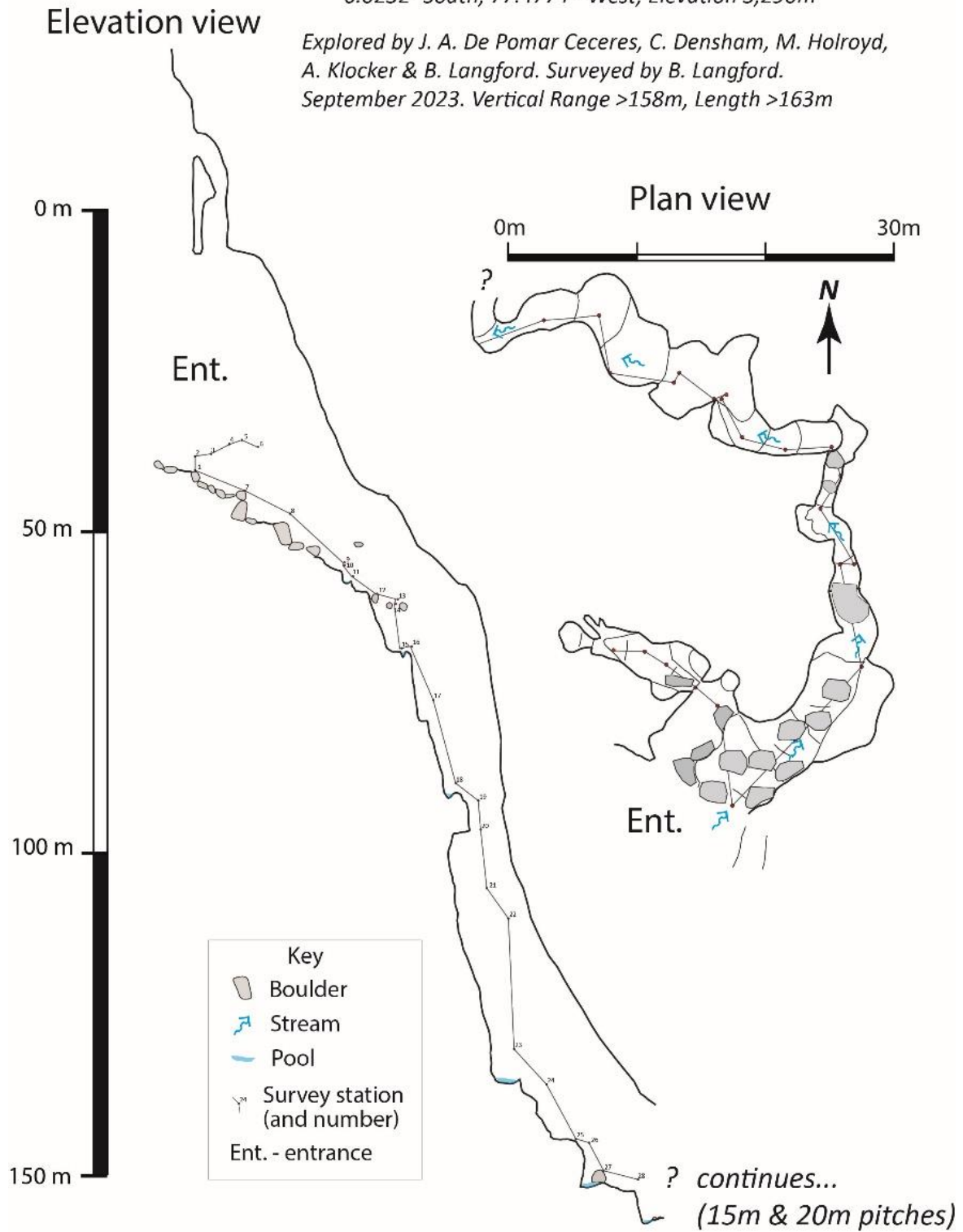


Figure 23. Survey of Tragadero del Ojo Derecho de Lorenzo (Lorenzo's Right Eye), drawn by PT.

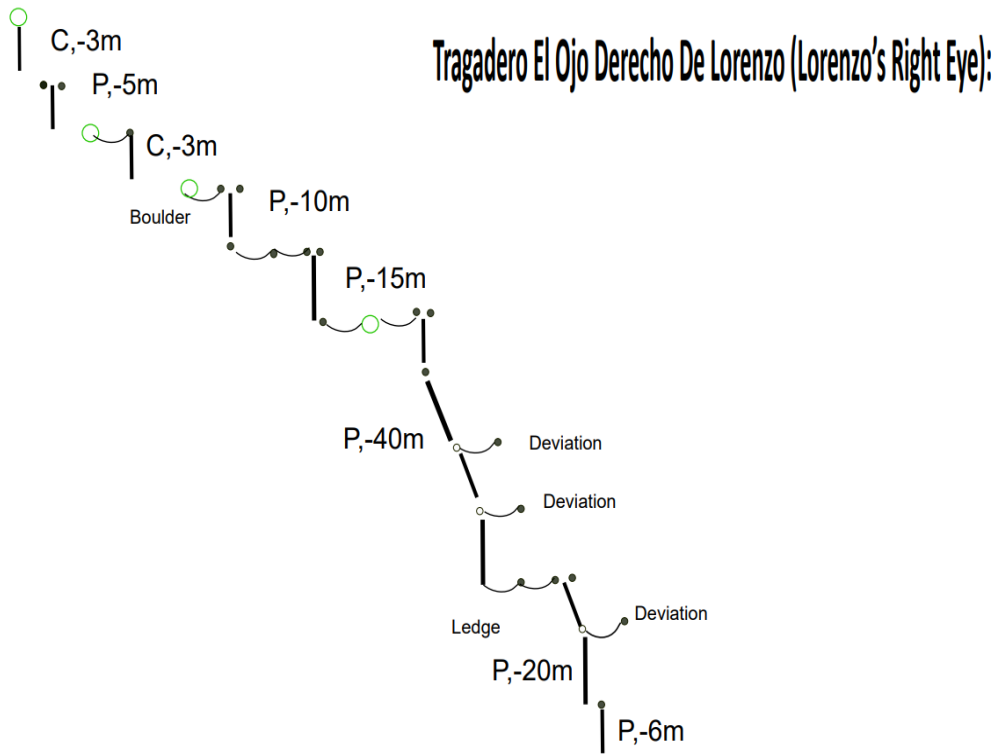


Figure 24. Rigging guide to Tragadero del Ojo Derecho de Lorenzo (Lorenzo's Right Eye), drawn by MH.



Figure 25. Entrance to Tragadero del Ojo Derecho de Lorenzo (Lorenzo's Right Eye). Photos by Boaz Langford.

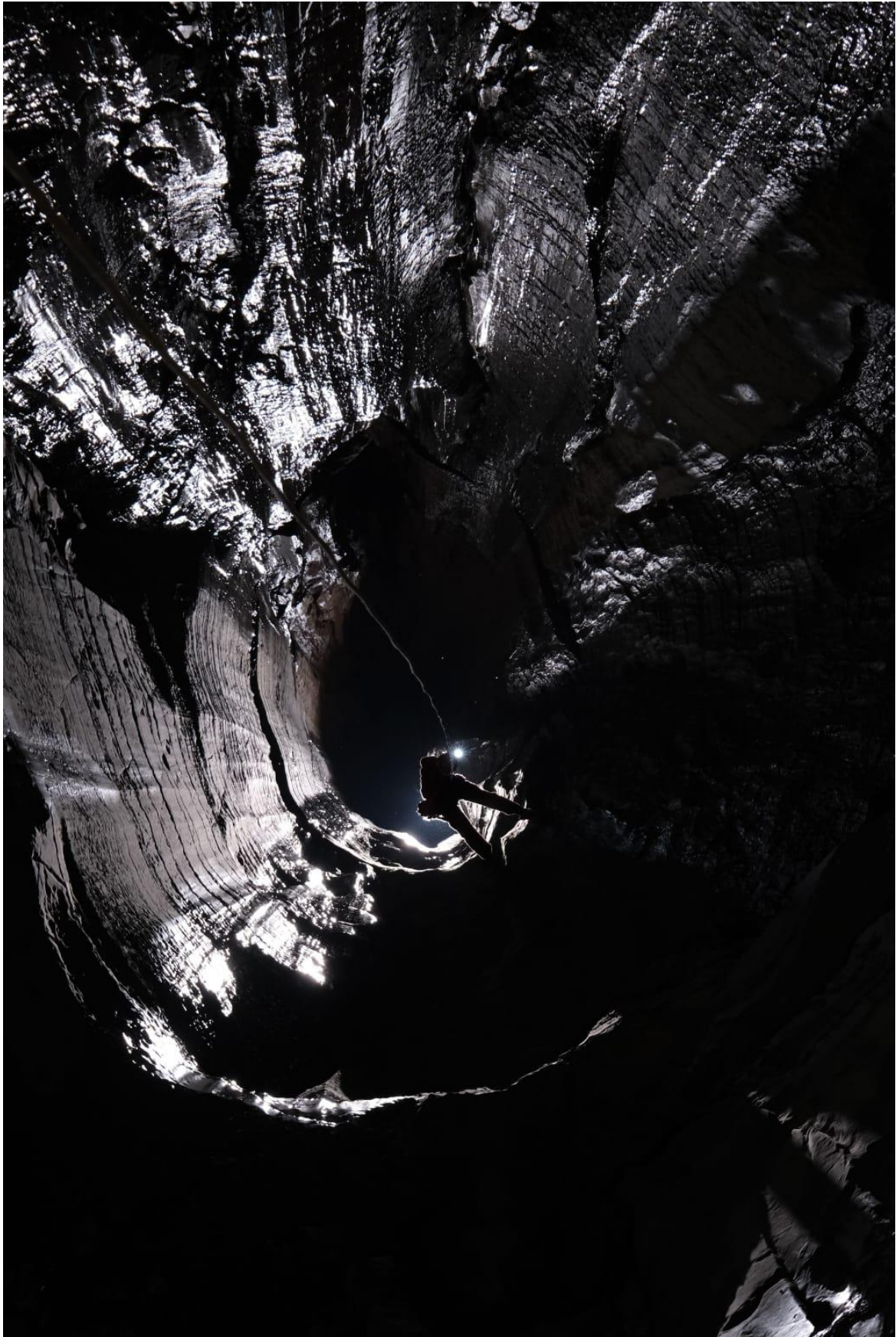


Figure 26. Shaft in Tragadero del Ojo Derecho de Lorenzo (Lorenzo's Right Eye). Photo by Boaz Langford.



Figure 27. Photos of shaft in Tragadero del Ojo Derecho de Lorenzo (Lorenzo's Right Eye). Photos by Boaz Langford.

Tragadero del Ojo Izquierdo de Lorenzo (Lorenzo's Left Eye):

-6.0251°S -77.4767°W; Length > 165 m; depth > 141 m, entrance elevation = 3,286m

The 'Left Eye' is the slightly smaller sibling of the 'Right Eye', with accordingly less water and draft, but both are very similar in character. Both eyes got their names from the fact that they are located almost perfectly symmetrical either side of a prominent ridge – the nose – painting a face into the landscape.

Similar to its sibling, this cave is almost entirely vertical, starting with a ~ 40m pitch that begins only metres into its ~ 20m high entrance. Like the 'Right Eye', this cave has a stream running into it which was dry for most of the expedition, despite heavy afternoon showers. After one full day of rain though, it started flowing substantially, and only dried out again two days after. Flood debris on the first pitch, in places where the laws of physics shouldn't allow, shows that one has to be very aware of flood risks when exploring this beauty.

The rock quality in this cave, to the point of exploration, is amazing, being a solid, dark-grey, and in many places scalloped, limestone. While using up a substantial amount of drill battery, one could at least be sure that the bolts we placed would be solid. The biggest challenge from a rigging point of view was to guess where water would go in the case of the flood, making sure one could exit the cave even under sub-ideal conditions.

The first pitch ended next to a large pool of water, which needed to be crossed to continue down the cave. With a bit of rock moving on the downstream end, the water levels could luckily be lowered enough to keep the gumboots dry. From there on, we descended pitch after pitch, with some meanders in between. In the lower parts of the cave there are a few places where the cave looks like it always stays dry, even in a flood, and hence there are places to wait out a flood. Some short ropes might need to be placed there for comfort and safety.

Towards the end of the current exploration, the meander became a bit smaller (we had to move sideways for the first time and duck, ouch!), and the draft became even more chilling. Here we also encountered some very nice calcite features. At this point we were out of rope. Martin continued on, down one more 3m tricky climb (which needs a rope in the future), and saw that the cave immediately opened up again, with a 3-second pitch following.

Given that this cave seems like one large, extremely tall, meander, with a draft and often active stream, there's no question, we need to get back here asap (with lots of rope and bolts)! There's hopefully still a further 2.3km to go down vertically...

Tragadero El Ojo Izquierdo De Lorenzo

Vista Alegre, Rodriguez de Mendoza, Amazonas, Peru.
6.0251° South, 77.4767° West; Elevation 3,286m

Explored by J. A. De Pomar Ceceres, C. Densham, M. Holroyd,
A. Klocker & B. Langford. Surveyed by B. Langford.
September 2023. Vertical Range >141m, Length >165m

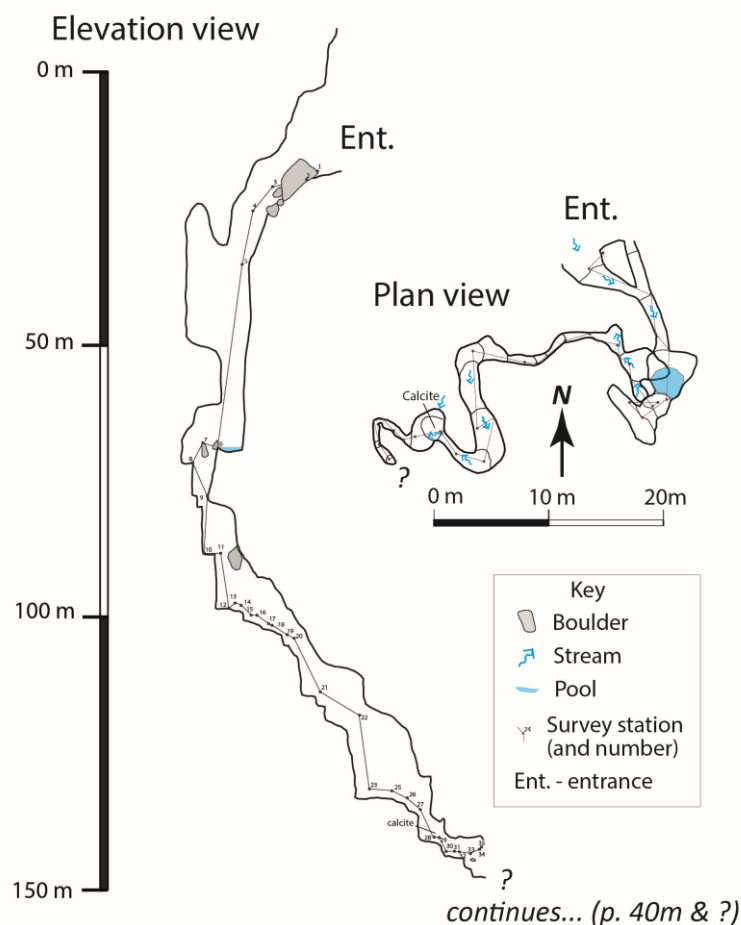


Figure 28. Survey of Tragadero del Ojo Izquierdo de Lorenzo, drawn by PT.

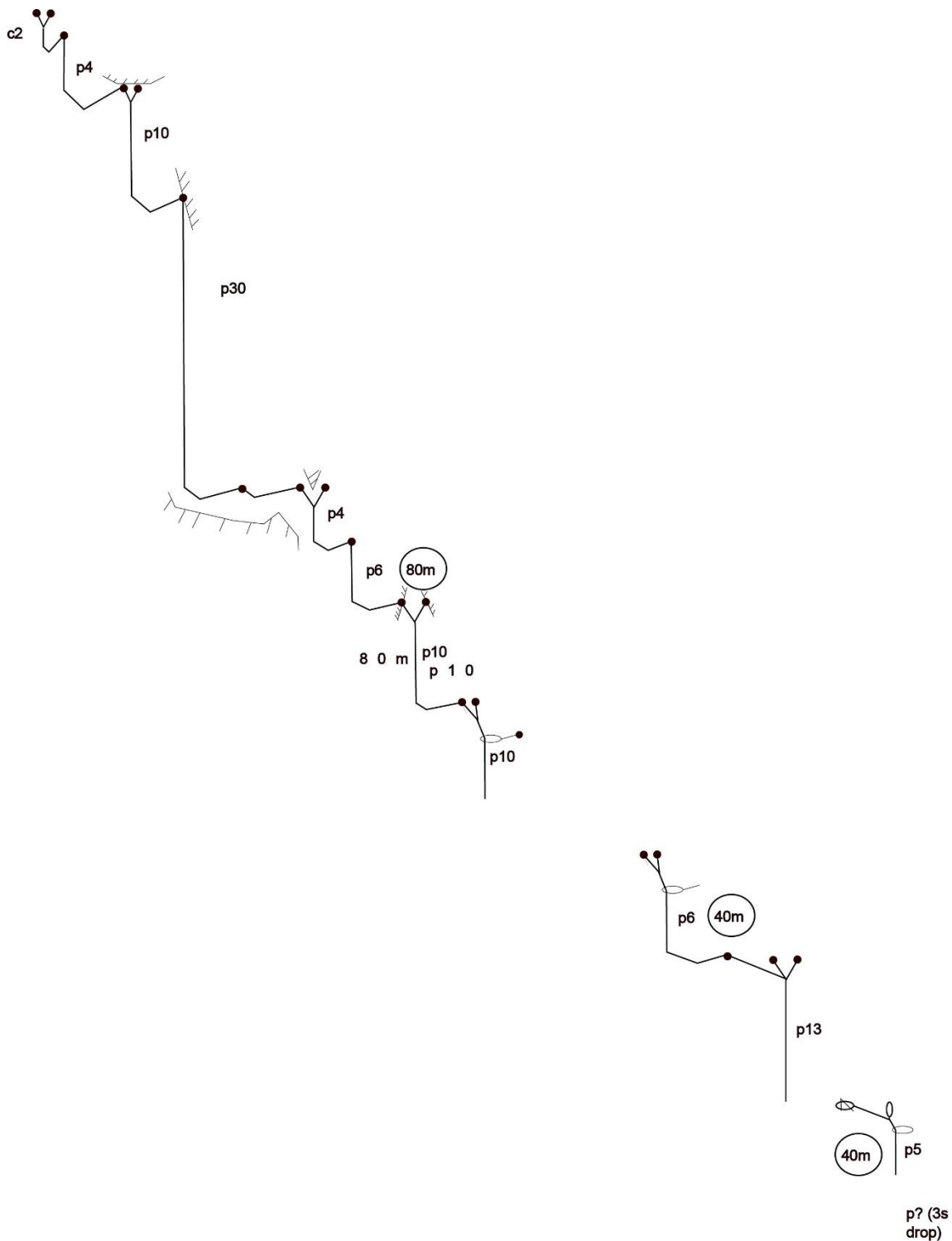


Figure 29. Rigging topo for Tragadero del Ojo Izquierdo de Lorenzo, drawn by CD.

Sites near Lorenzo’s Sinks: The first site is in a line with the eyes of Lorenzo; if you walk from right eye to the left eye, and then continue in a straight line for the same distance again. This is a large doline, maybe 20 m in diameter, and it is surrounded by extremely sharp and loose pinnacle karst. Due to this challenging terrain, we did not descend into the doline. We could see a tree growing at the bottom, and thrown rocks suggest a mud bottom. Hence, as far as we can tell, this doline is plugged, but if someone is keen in the future this might be worth another look, but not as a high priority. The other hole is to the east, down the hill from both of Lorenzo’s Eyes. We entered through a small gap in a vegetation-covered rockpile. The cave continued for about 30 meters, down

some little climbs. Then came a tight restriction, which only CD could get through. Shortly after followed an even tighter restriction which Chris couldn't fit through either, and it looked like this went into a boulder collapse. This cave is quite drippy, and looks like it might still take some water when it is raining, but there's no realistic prospect for further exploration.

Search for additional resurgences: Group 1 spend a very challenging day checking for resurgences along the river valley to the southeast of Tragadero 1 de la Planura del Pico del Oro, where it was extremely difficult to make progress due to the vegetation (see yellow track on overview map; Fig. *). However, they came back with the important result that there are no major resurgences along this river valley. This hard-won observation means there are no known resurgences in this area around Tragadero 1 de la Planura del Pico del Oro. Water that goes underground in a series of major sinks (including Tragadero 1 de la Planura del Pico del Oro, Lorenzo's Right and Left Eyes and Tragadero de la Soledad must travel for a significant distance, beyond the margins of the plateau.



Figure 30. Examples of the dense vegetation that can sometimes be encountered in mega-dolines and river valleys within the eastern area, to the south and east of Tragadero 1 de la Planura del Pico del Oro. Both photos taken on a reconnaissance trip to a mega doline. (Photos by Martin Holroyd).

Megadoline Closer to Tragadero 1 de la Planura del Pico del Oro Camp:

The mega doline was an epic walk to a very large feature, but with no significant cave, which was a disappointment. We ended up being distracted attempting to reach the marked P1. We had hoped to reach P1 by an alternative route, as the route to Lorenzo's sinks had been difficult. Initially the walk began well with a steady climb on easy ground then deteriorated rapidly into steep, rocky and vegetated ground. Whilst looking for an easy way down a steep slope we noted a huge and enclosed doline to our right and decided to take a look. Easier said than done, firstly the distance to the doline was foreshortened and the vegetation was impenetrable, overgrown bamboo being partially challenging without a bush knife (Fig. 30). Finally, the base of the doline was reached with no significant cave to explore; a c.5 m long passage connected 2 small entrances with a degenerating inlet at the bottom. A disappointing end and we still had to climb back out. We never did reach P1.

Margins of Valley of Tragadero 1 de la Planura del Pico del Oro: The expedition also searched for cave entrances around the valley that contains Tragadero 1 de la Planura del Pico del Oro, along the margins of the limestone. In some cases, these sinks had already been visited by previous expedition in 2018 and 2019 (Nord Perú, 2018, 2019). But their descriptions are included for completeness.

Sink 17 (Tragadero 6 de la Planura del Pico de Oro – Nord Perú 2019 expedition):

-6.0450°S -77.4974°W; Length ~30 m; depth ~7 m, entrance elevation = 3,296m

This is a significant river sink on the southwestern margin of the valley, where the river has again cut down a short gorge. The stream can be followed for ~15m, before entering a choke. There is currently no way on. However, there is a squeeze on the right, just after a 1m climb down at the end, which could be enlarged. This would need a crowbar or hammer, and possible capping or plug-and-feathers. But a somewhat larger space can be seen beyond, which might possibly continue. The stream sink is well located beyond the current downstream sump of Tragadero de la Soledad.

A series of other dolines and sinks were explored around the margin of the limestone in this valley. The most significant is Sink 18 (which is Tragadero del Oso from the Nord Perú 2019 expedition), but this is indeed choked. No other passable entrances were found along the limestone margins, but two small holes carried a significant draft (23B1 and 23B4 in the coordinates list).

We did not enter Tragadero 1 de la Planura del Pico del Oro, as previous expeditions have pushed to a conclusion (Nord Perú 2019). Bear noises were reported from the pit just behind the main sink.

Mega-doline P10: A solo trip by BL was made to a pair of very large collapse-dolines (P10 in the GIS), which were reported to be impressive features. No entrances were seen, and the terrain and dense vegetation within the mega-dolines would be challenging for future visits, which would need rope.

This reconnaissance also found entrances BA1 and BA2, which were choked, although they could be dug (see Coordinates List).

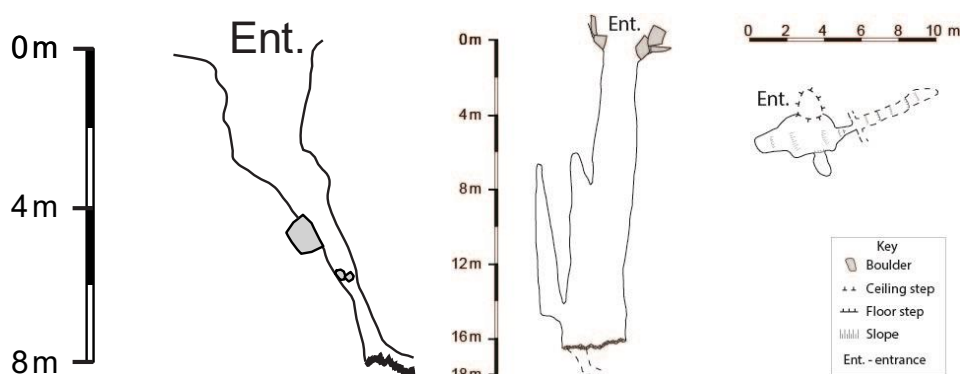


Figure 31. Sketch surveys of BA-1 (left) and BA-2 (right) that ended in chokes.

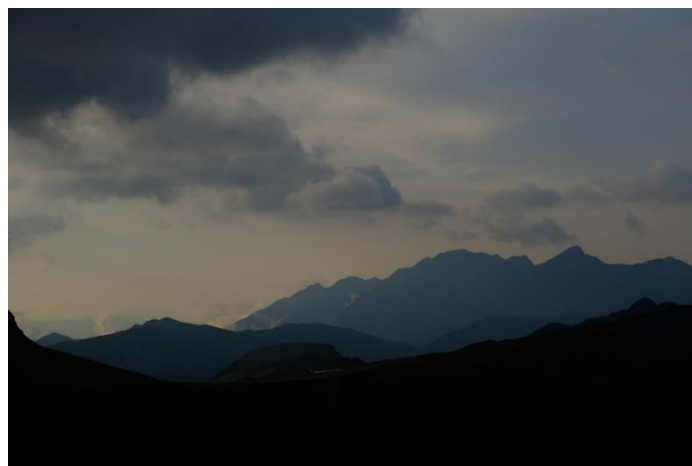


Figure 32. View of the eastern edge of the plateau (Photo by Boaz Langford).



Figure 33. Milky way and night sky at Calamina Camp (Photo by Boaz Langford).



Figure 34. Light and shade at camp next to Tragadero 1 de la Planura del Pico del Oro, which was often colder than Calamina Camp. Photo by Martin Holroyd.

Notes on Logistics

Airports: Jaen airport was closed for repairs, so we had to fly to Tarapota at short notice, and this meant a longer bus journey (9-10 not 4 hours) to Chachapoyas. But it is likely that the Jaen airport will be open in 2024, and is preferable. One caver (AK) successfully flew from Lima to Chachapoyas, to catch up the main party and horses, but this route only allows one 15 kg hold bag; it may be ok for one caver, but is not a way to transport heavy group materials, as well as having carbon implications.

Horses: During this expedition, 9 horses were used to carry equipment up to Calamina Camp on the way there from Granada. This journey had taken 2 days in 2022, but was feasible in one long day, which simplified logistics considerably. Each horse carried about 3 large (23 kg) bags when fully laden, and were most impressive. A combination of 2 horses and 6 horses carried the equipment down to Granada, and 2 horses were used to help carry equipment to Group 1's satellite camp.

Satellite Camps: A key aspect of the 2023 expedition was successful use of entirely self-sufficient satellite camps on the plateau, allowing teams to be based closer to cave entrances, and thus avoid long daily commutes. The next section reflects on this strategy, with suggestions for modifications.

In 2023, our local guides (Lorenzo, Rosa, Gilberto et al.) kindly cooked excellent meals for 2 days on the journey to the plateau and during the return journey, which helped to minimise the dehydrated meals we then carried. Group 1 (5 cavers) set up a satellite camp for 10 days near to Tragadero 1 de la Planura del Pico del Oro (Fig. *), before joining Group 2, whilst Group 2 (5 cavers) remained at Calamina Camp throughout the entire expedition, and assisted with two carries of kit to Group 1's camp. Two horses were used to help transport heavier equipment from Calamina Camp to Tragadero 1 de la Planura del Pico del Oro, but once some food had been eaten and rope stored in caves, the materials were carried back to Calamina Camp by the combined 10 cavers.

A good future satellite camp site was found near to Sink 2, and not far beyond Tragadero de la Soledad, with at least 10 flat tent pitches (maybe more), and is indeed much flatter than Calamina Camp. It would be possible to use horses to carry kit to this camp, but maybe in a second short day from Calamina Camp. A good satellite camp location ('Scottish Camp') is located next to a small lake, by Lorenzo's sinks. It may be worth exploring whether Lorenzo can help build a shelter at this site.

Evening meals: The team transported almost 250 dehydrated meals (weighing ~50 kg) onto the plateau, and benefitted greatly from sponsorship by Firepot and Adventure Nutrition. These meals were chosen to have high protein levels, and were a great success. They remained remarkably tasty and popular, even after being eaten every day. Each dehydrated meal has 700 to 1,000 kCal of energy, and the original plan was thus to eat 1.5 meals per person per day, as we sought to reach intake of ~3,500 kCal/day. However, it proved tricky to eat 1.5 of these filling meals, as originally planned, so on most occasions a dehydrated meal was augmented by ramen noodle packets (about 400kCal). The expedition also functioned very happily (if a bit windily) on probably about 2,500-3,000 kCal/day. Ninety of the dehydrated meals are stored at Luya for 2024.

Breakfasts: 30kg of (artesenal) granola was procured by Tonio in Cajamarca and carried onto the plateau, together with 5 kg of chocolate Milo powder. These breakfasts were also a major success, and also sometime again varied with ramen noodles (we carried about 120 ramen noodles bought in Chachapoyas onto the plateau). A 200kg serving of granola would approach 1,000 kCals.

Lunches: We bought lunch materials in Chachapoyas, including tortillas, peanut butter, dried meat, jam and honey, and mayonnaise. The resulting wraps were very tasty, but we only budgeted for 2 tortillas per person per day. In hindsight, this needs to be increased for next year. We also had

various 'trail food' including one granola bar per person per day. Individuals augmented their ration with things like condensed milk sachets, chocolate etc. A variety of lunch material is also good for catering to different tastes.

Water: Water was typically filtered before use, and some people also added chlorine tablets.

Health: There were no issues with people getting seriously ill, as occurred to two people in 2022.

Waste: Waste was carried out, or for human waste - buried with a trowel in specific locations

Fuel: We originally bought 22 litres of gasoline (unleaded petrol), but some leaked from initial containers, and when being carried by horses, so we may have only had 15 litres of fuel by the time we arrived at Camp Calamina. This was insufficient for all cooking, so we had to also use an open fire for cooking for ~3 days, and appreciate Rosita's and Lorenzo's efforts to leave us firewood. In future years, we may need to take more than 15 litres of fuel, especially for larger or longer satellite camps, or if there is substantial charging of drill batteries by the generator (but see below).

Solar charging: This was successful for smaller items, with only drill batteries being charged via a small generator. It may be worth exploring if drill batteries can be charged via a solar panel in 2024.

Caving Equipment: We carried 650m of rope onto the plateau, which comprised 400m of new Korda 9mm rope, and 250m of rope from the ECA-GSBM tackle store located at Liz's parents' house in Luya. The 400m of Korda rope has been stored at cave entrances for use in 2024, when we will need a much larger total amount of rope. We eventually just used 8mm through-bolts for rigging, with both 65 and 80mm lengths. The presence of mudstone intervals means that those longer lengths are probably justified, although much of the rock is very good.

Capacity building and support for Peruvian cavers: Martin Holroyd kindly brought a stretcher to donate to Peruvian cavers. We hope this area, and future expeditions in this area, will provide further inspiration and capacity building. The expedition supported our Peruvian colleague - Tonio Cáceres with all expedition costs in the field, and his rent, to allow him to participate fully. Horses were hired without intermediaries from the local people in the village of Granada.



Figure 35. MH demonstrating the stretcher brought from UK and donated to Peruvian Cavers.

References

- Baby P. (2023). Le potentiel du Cerro Blanco. Bulletin ECA-GSBM, Nord Pérou 2022: 11-13.
https://www.gsbm.fr/publications/gsbm/2023_NordPerou-2022/NordPerou2022-11-13.pdf
- Baby P. (2020). Géologie des massifs karstiques du Nord-Pérou. Bulletin ECA-GSBM-GSD-GSVulcain, Nord Pérou 2019: 8-11.
https://www.gsbm.fr/publications/gsbm/2020_NordPerou-2019/NordPerou2019_008_Baby.pdf
- Klein, J-D., Guyot J.L., Robert X., Apaestegui J., and Bigot J.Y. (2019). Pérou. Spelunca, 158:1-9.
https://www.gsbm.fr/publications/perou/2019_Spelunca_153_Bigot.pdf
- Bigot, JY. Approche géomorphologique du massif de Cerro Blanco. Rapport NOR PERÚ 2018 : Expédition spéléologique franco-péruvienne du 10 août au 12 septembre 2018, 71-76 (2019).
<https://www.gsbm.fr/expeditions-speleo-perou/expedition-nord-perou-2018/>
- Bigot J.Y. (2019). Reconnaissance aux lacs de Granada. Bulletin ECA-GSBM-GSD-GSVulcain-UNAM, Nord Pérou 2018: 51-60.
http://www.gsbm.fr/publications/gsbm/2019_NordPerou-2018/NordPerou2018_051_Bigot.pdf
- Grandjouan, O. et al., 2017. Las resurgencias del Alto Mayo (San Martín, Perú): Estudio hidrológico sobre un karst tropical andino-amazónico: Sociedad Geológica del Perú, Volumen Jubilar N° 8: 83-96. <https://repositorio.igp.gob.pe/handle/20.500.12816/2177>
- Guyot, 2019. Histoire de la Spéléologie au Pérou. In 2019 Nord Pérou Expedition Rapport d'expédition.
https://www.gsbm.fr/publications/gsbm/2020_NordPerou2019/NordPerou2019.pdf
- Guyot J.L., Bigot J.Y. (2023). Peru. Spelunca, 170:3-9.
https://www.gsbm.fr/publications/perou/2023_Spelunca_170_Guyot.pdf
- NORD PERÚ 2018 Expédition spéléologique franco-péruvienne. Rapport d'expédition
<https://www.gsbm.fr/expeditions-speleo-perou/expedition-nord-perou-2018/>
- NORD PERÚ 2019 Expédition spéléologique franco-péruvienne. c.
https://www.gsbm.fr/publications/gsbm/2020_NordPerou2019/NordPerou2019.pdf
- NORD PERÚ 2022 Expédition spéléologique franco-péruvienne. Rapport d'expédition
<https://www.gsbm.fr/expeditions-speleo-perou/expedition-nord-perou-2022/>
- Staccioli, G. (2023). Gold Peak. Bulletin ECA-GSBM, Nord Pérou 2022: 32-36.
https://www.gsbm.fr/publications/gsbm/2023_NordPerou-2022/NordPerou2022-32-36.pdf
- Talling, P. (2023). Big Sink / Tragadero Grande. ECA-GSBM Bulletin, Northern Perú 2022: 37-38.
https://www.gsbm.fr/publications/gsbm/2023_NordPerou-2022/NordPerou2022-37-38.pdf

GPS Coordinates of Caves Explored (and Other Sites)

Cave or Site	Region	Province	District	Longitude	Latitude	Alt.	Length	Depth	comments
Western Area (with line of sinks) – explored by Group 2									
Tragadero de la Soledad (aka Solitude Sink, & previously called 'Bigger Sink' in 2022 expo report)	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5153° W	6.0648° S	3418m	2,337 m	205 m	Downstream streamway ends at sump, but possible way over top. Upstream ends at huge choke; one poss. lead
Tragadero Rayo Urmana	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5211 ° W	6.0631 ° S	3528 m	192m	65 m	Impressive start but chokes (see survey)
Sink 2	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5128 ° W	6.0687 ° S	3408 m	>195 m	16 m	Open, but may end in bad air
Sink 3	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5112 ° W	6.0713 ° S	3438 m	n/a	n/a	Choked by landslide
Sink 4	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5082 ° W	6.0763 ° S	3471 m	n/a	n/a	Large doline. Choked.
Sink 5	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5076 ° W	6.0769 ° S	3483 m	n/a	n/a	Entrance only. Ongoing, and looks good, after 5m pitch (undescended)
Sink 6	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5036 ° W	6.0846 ° S	3483 m	n/a	n/a	Ongoing. Not fully explored, in a vegetated canyon.
16-1 Cave (discovered in 2022; pushed in 2023)	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.5211 ° W	6.0587 ° S	3542 m	~12m	~12m	Ongoing. Needs 5-10m rope. Not surveyed.
Eastern Area – explored by Group 1									
Tragadero del Ojo Izquierdo de Lorenzo (Lorenzo's Left Eye)	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.4767° W	6.0251° S	3286m	165 m	> 141 m	Ongoing (Beyond survey is 40m pitch)
Tragadero del Ojo Derecho de Lorenzo (Lorenzo's Right Eye)	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.4774° W	6.0232° S	3290m	163 m	> 158m	Ongoing. (Beyond survey is 15 m pitch/climb down, and 20 m pitch...)
Sink 17 (Same as Tragadero 6 de la Planura del Pico de Oro - NorPerú2019 expedition)	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.4974° W	6.0450° S	3296m	~30m	~7 m	Stream cave for 20m but then choked. Squeeze could be enlarged for thin caver?
Sink 18 (Same as Tragadero del Oso - NorPerú2019 expedition)	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.4915° W	6.0433° S	3283m	n/a	n/a	Choked. No way on found.

BA-1	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.48554° W	6.030087° S	3368m	9.6 m	7.8 m	Block by boulder choke. Potential for digging
BA-2	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.485218° W	6.030167° S	3410m	40.3 m	17.2 m	Small potential for digging
23B1	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.4909° W	6.0381° S	3272m	n/a	n/a	(Too) small hole close to unpassable river sink, with significant draft
23B4	Amazonas	Rodriguez de Mendoza	Vista Alegre	77.4978° W	6.0440° S	3278m	n/a	n/a	Significant draft but digging needed



Figure 36. View towards Tragadero 6 de la Planura del Pico de Oro from above Calamina Camp.



Figure 37. The Venus de Milo chamber in Tragadero de la Soledad (photo by Mike Futrell).

Expedition Budget: Income and Expenditure

Income	
Mount Everest Foundation Grant	£5,500
Ghar Parau Grant	£1,000
	Total = £6,500
Expenditure	
<i>Hire of 9 x Horses to Carry Equipment, and Local Guides in Granada</i>	£1,141.30
<i>Safety</i>	
Items in Group Medical Kit	£56.97
2 x Garmin Satellite Texting Phones (now available to other caving expos)	£864
Subscriptions for 2 Garmin Satellite Phones (set up and 1-month texts)	£180
Subscription to third Garmin Satellite Phone (owned by AK)	£64
<i>Food for High Plateau</i>	
84 x Firepot dehydrated meals	£732.46
156 x Adventure Nutrition dehydrated meals	£1,111.51
30 kg Granola (bought in Cajamarca)	£201.62
5kg Milk powder	£80.66
Other food up the hill (e.g. for lunches, and additional evening meals)	£603.29
Fuel	£26.09
<i>Caving Equipment</i>	
Bolts and Hangers	£342.00
Rope (200m from Korda)	£432.00
Rope (200m free via sponsorship)	£0
Bolting Hammer and Drill Battery	£124.99
<i>Group Travel</i>	
Tarapoto to Chachapoyas	£370
Chachapoyas to/from Granada	£261.45
Chachapoyas to/from Luya	£6.53
<i>Miscellaneous</i>	
Group Shelter	£100.00
Survey Notebooks and Pencils	£84.00
Extra Bags on Flights	£306.00
Support for Peruvian Cavers (TdC)	£382.34
	Total = 7,472.21

Carbon footprint of the expedition compared with original estimates in application.

<i>Original Estimates (based on 12 persons)</i>	
International flights: EU to Lima	40.01 tCO ₂ e
Internal flights (Lima to Tarapota)	4.3 tCO ₂ e
Minibus for whole team (Jaen-Chacapoyas)	0.063 tCO ₂ e
<i>Carbon Footprint of Expedition (10 persons)</i>	
International flights (London/Paris) to Lima)	33.34 tCO ₂ e
Internal flights (Lima to Jaen)	3.58 tCO ₂ e
Minibus for whole team (Tarapota-Chacapoyas)	0.063 tCO ₂ e

Carbon offsetting or carbon reduction measures included travelling by a single minibus from Tarapota to Chachapoyas, and the overall size of the team was eventually reduced from 12 to 10 EU-based cavers. A variety of UK-based carbon-offsetting schemes were used by individual expedition members.