

2021 Sistema Cheve Expedition: Initial Report

The findings presented here are preliminary. A detailed review of the field survey data is still underway. Updated formal maps will take another 6 to 12 months to complete. Initial computer-generated line maps are presented below. These graphically illustrate at a glance the progress made by the 2021 expedition.

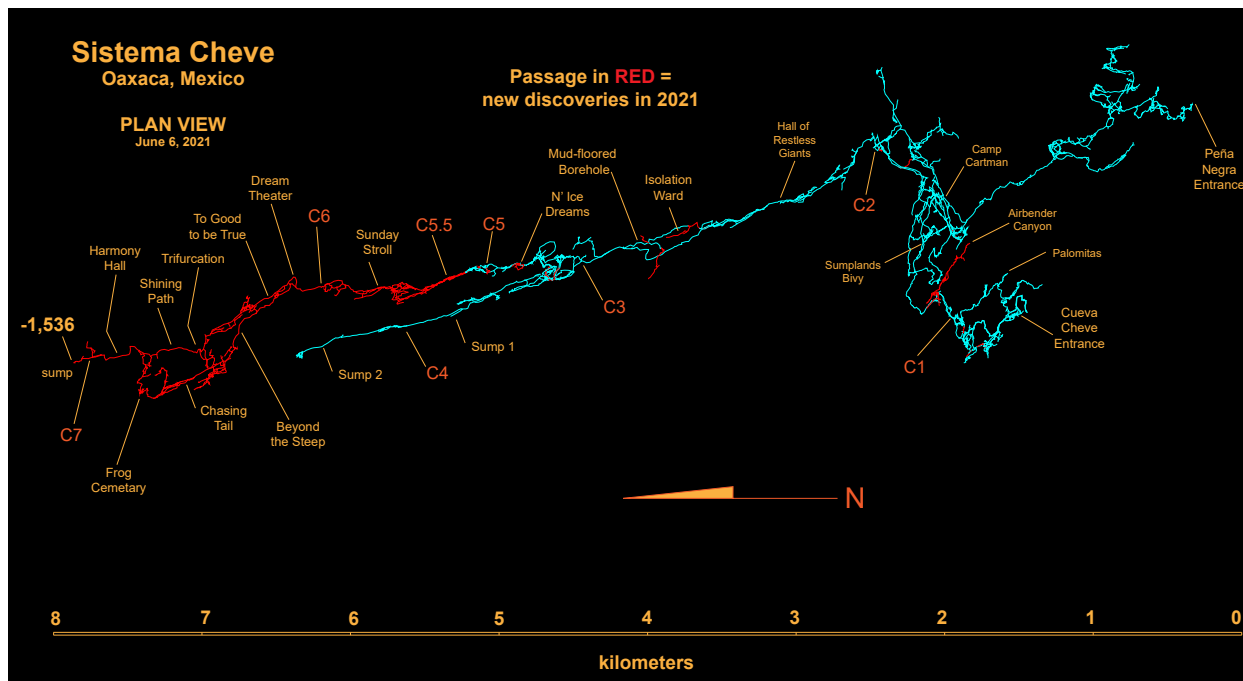
Perhaps the single most significant statistic from the expedition is that 20.1 kilometers of previously unknown cave were discovered in 2021 in Cueva Cheve alone. For a predominantly vertical, deep caving expedition, this represents a stunning increase to the known extents of the cave system. The northern limit of Cheve has, after nearly 30 years of effort, finally been extended beyond the sumps as well as beyond the breakdown collapse at the end of Sump 2. The majority of the new cave discovered in 2021 was, in fact, north of the previous exploration limit, reached by divers on the 2017 expedition. These new tunnels are mostly horizontal in nature (although there are level changes of nearly 300 meters between some sections of the labyrinth). The vast majority of the tunnels averaged 40 x 40 meters in cross section and in places reached 60 m wide by 80 m high (notably at *Harmony Hall*). The exploration limit has now progressed beyond the northern extent of the high karst plateau and is now directly below the town center of the village of San Miguel Santa Flor, at a depth of 600 m below the surface, and aligned with the axis of the valley that descends through Santa Flor. The current length of the Cueva Cheve – Peña Negra cave system is 76,735 meters. The system depth increased modestly to 1,536 meters.

An enormous amount of effort was involved in these achievements. A total of 3,156 person days were logged on site by a team of 69 expeditionary cavers from 9 countries. Of these, 1,531 person-days were based from underground camps in Cueva Cheve. A large percentage of those that comprised the exploration teams working from Camp 6 spent more than 80% of their time on the expedition working underground. Not counted in these figures are an additional 110 person-days spent hauling equipment and food from basecamp to the Saknussem's Depot (-650 m level of the cave) on round trips from the surface without camping.

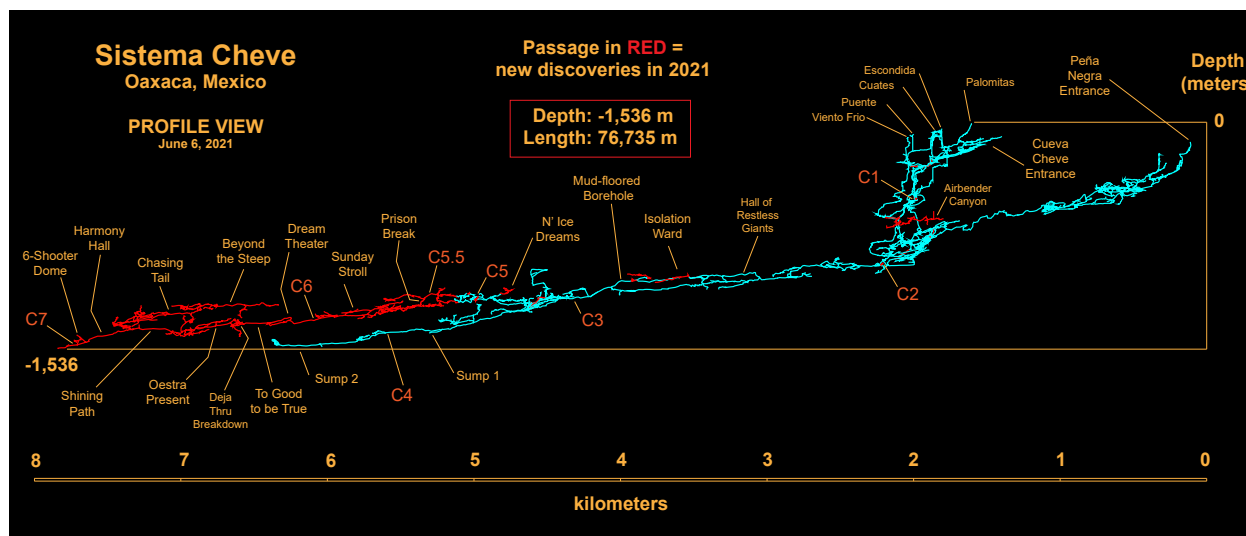
The expedition made use of four existing underground camps in Cheve and the Peña Negra and established four new ones in 2021 at the most remote reaches of exploration in Cheve. Locations for each camp are shown on the plan and profile maps below. Other statistics are discussed in the section on logistics below.

Location:	Number of Person-Days Occupied	Distance from the nearest Entrance (meters)
Camp 1	203	1,183
Camp 2	369	3,521
Camp 3	325	6,288
Camp 5	164	7,579
Camp 5.5	155	8,170
Camp 6	217	9,480
Camp 7	9	11,651

Table 1: occupancy at underground camps in Cueva Cheve in 2021 and traverse distance to those camps.



Plan View map of Sistema Cheve as of June 2021.
Line map extracted from the WALLS cave survey program



Profile View map of Sistema Cheve as of June 2021.
Line map extracted from the WALLS cave survey program

Chronology 2021:

Final organization began in Austin, Texas on January 15, 2021 and the team returned on April 30, completing a 106 day effort involving 69 expeditionary cavers from 6 countries. By mid-February the lead rigging team reached Camp 3. It was during this time that the first significant discovery of the expedition was made. Teams working from both Camp 2 (C2) and Camp 3 (C3) were able to achieve a connection between the southern end of the *Mud Floored Borehole* and the northern extension of the *Hall of Restless*

Giants. Between these two locations lay the *Isolation Ward*, a newly discovered chamber measuring 40 m wide, up to 20 m tall, and 300 m long. It was lined with impressive formations, including extensive aragonite crystals, a rarity in Cueva Cheve. The new connection completely bypassed the traditional Black Borehole route and reduced travel time from Camp 2 to Camp 3 by up to 90 minutes.

Despite a month of effort, primarily in the transport of equipment and food as well as route safety improvement beyond C3, it was not until February 20th that Camp 5 was established, at the north end of Purgatory Borehole, near the exploration limit reached in 2019 (see the book on the 2019 expedition available [here](#)). A transit from C3 to C5 with equipment and food (usually carried in 22 liter packs due to the constricted nature of the 500 meters of the crawling / squeezing traverse comprising the *Gone with the Wind*, *Mad Hatter*, and *Mad Cows* breakdown complex) typically took between 4 to 8 hours, depending on the load, familiarity with the route, the acclimatization state, and fitness of the team.

The naming convention for underground camps in Cheve includes Camp 4, established in 2017 beyond Sump 1 in the main river passage. But this was not on the “trade route” deeper into the cave in 2021, so a typical one-way trip to the most remote place in Cheve in February 2021 went from basecamp to C1 to C2 to C3 to C5. For the following 3 weeks exploration parties, based out of C5, plunged again into an extensive breakdown zone leading to the north for a distance of nearly 500 meters. A pattern began to emerge in which it became apparent that the cave occupied multiple vertical levels within the limestone strata. The lowest level carried the Cheve river. After C3 we never saw the river again in 2021, and this remains a great mystery. The middle layer was an apparently collapsed “super tunnel”, the bottom two thirds of which were filled with breakdown (to a depth of 60 meters). Atop this breakdown, if you could find your way upwards through the maze, were occasional stretches of open large, well-decorated, dry borehole, typically 20 m or more in width and varying height up to 40 m. The first of these “attic” rooms was given the name “*Northwest Passage*”. In quick succession more such chambers – with colorful names like *The Tomb of Asgard* and *The Treason of Isengard* – separated by short collapsed sections of breakdown, were discovered, all leading northward. All levels remained on the predominant northwest-southeast fault trend that controls much of the development in Sistema Cheve. But these chambers proved, in the end, not to be the way onward. Rather, it was evident that the air flow was proceeding back into the middle breakdown level, which rapidly slowed progress.

On March 10th advance teams established Camp 5.5 in the Northwest Passage, 2.5 hours beyond C5. Although only 591 meters distant from C5, the route involved innumerable body-tight squeezes in the breakdown. From C5.5 they continued the slow, difficult exploration of the complex breakdown maze. Within a week, however, a major breakout into 40 x 40 m borehole (*The Sunday Stroll*) was discovered and this tunnel was rapidly explored and mapped to a point nearly a kilometer to the north of C5.5. Importantly, it was the first time anyone had gone further north in Cheve than the terminal breakdown blockage at the end of Sump 2.

Given the time-consuming transit through the breakdown (which took up to 3 hours beyond C5.5 before reaching the large tunnel) an effort that is likely unprecedented in cave exploration took place to find a bypass. The Cheve project, since 2017, has made a complete shift from traditional cave survey (pencil sketch on paper and optical instruments) to an all-digital approach that uses hand-held lidar (a DistoX2 instrument) that wirelessly transfers data to a tablet running the program Topodroid, which allows digital sketching. The latest version of Topodroid integrates the 3D data viewing package known as “Cave3D”. Using this equipment, it was possible to conduct real-time surveying in a previously unknown section of the cave and immediately see where the new tunnel was positioned relative to other known tunnels. Using this feature, teams at C5.5 realized that a point almost in the *Sunday Stroll* tunnel was directly below the deepest point in the northern end of the *Northwest Passage*. They then, optimistically, began looking for openings leading upwards in the massive breakdown complex. With each move upward they compared their position to the target point 60 meters vertically above in the *Northwest Passage* and chose openings between the boulders leading in that direction. After 3 days of intense work they emerged in the Northwest passage – a phenomenal accomplishment that would never have been predicted absent the new technology to guide exploration. This new route – the *Prison Break* – cut 2.5 hours from the commute time to the large passage.

Camp 6 was subsequently established near the end of the *Sunday Stroll* on March 21 with an initial advance team of four. By March 24th the giant *Dream Theater* chamber (50 meters in diameter) had been discovered and the cave advanced yet another kilometer northward in the *Too Good to be True* tunnel, maintaining the 40x40 meter cross section. There, a third major section of breakdown was encountered (*Deja Thru*) where



Cheve 2021 De-Rig Team: left to right (rear): Oscar Berrones, Ben Zupo, Bryce Smith, Kara Posso, Tristan Stahl, Cait McCann, Victor Bravo, Gilly Elor, Mowgli Shwartz, Max Koether, Yaz Barragan, Adam Byrd, Kristen Anderson, Katie Graham, Colin MaGee, Casandra Mosley, Elliot Guerra-Blackmer, Raf Sieradzki, Bill Stone, Reilly Blackwell, Sean Lewis, Rob Gowler, Tommy Polson; front row left to right: Jordan Toles, Raul Calderon Martinez, Georgia Schneider, Adrian Miguel-Nieto, Amy Morton, Mary Hicks, Bev Shade, Kasia Biernacka, Vlad Paulik, Jeremy Bruns, Ron Rutherford, and Abigail Mack.

exploration was temporarily stalled. A crew change out at C6 took place on March 24th and further effort was directed to finding a way beyond *Deja Thru*. Just 30 meters past the March 24th limit, some 50 meters into the *Deja Thru* breakdown pile, the team again broke out into a continuation of the open tunnel, now named *The Oestra Present*. This continued for a further kilometer to an enormous chamber (60 x 70 meters in plan area) that branched in three separate, distinct directions: the *Trifurcation*.

During the last week of March and the first week of April more than 7 kilometers of tunnels were discovered in this area, comprising a 3-level labyrinth. The primary, north trending tunnel – the *Shining Path* – maintained the 40 x 40 meter cross section, larger in places, before opening into the gigantic *Harmony Hall*. This tunnel reached dimensions of 60 m wide by 80 m high... so big that it was not possible to clearly see the ceiling with our most powerful lights. Furthermore, a thermocline existed at the entry to the large chamber which created a persistent fog layer that complicated viewing of the highest sections of the tunnel. Further discoveries continued to the west of the *Trifurcation* junction, with the upper level tunnels (e.g. *Chasing Tail*) being up to 150 meters higher in elevation and creating a large loop that closed back with the *Shining Path* tunnel just before *Harmony Hall*. *Harmony Hall*, unfortunately, ended at a low flow sump, fed by a small stream that emerges from beneath the breakdown floor at the bottom of the chamber.

At this point - the first week of April - it was apparent that the continuation of the cave to the north was not obvious. We set up Camp 7 – the most remote underground camp ever established – and for three days in April we scaled the 75m tall *6-Shooter Dome* at the north end of *Harmony Hall*. This was a protracted, extremely overhung, ascent using rock bolts. The name came from the problem that we were running out of regular rigging bolts and as such the 75m climb was done mostly by using (and re-using) removable Petzl Pulse bolts, of which we had only 6. We had hoped to discover the continuation of the main tunnel at the top. Unfortunately what tunnel may have been there was completely blocked by flowstone.

At this point we began a re-investigation of all passages beyond the *Trifurcation* junction. Through various climbs, we found another 4 kilometers of tunnels, but none of them continued further north than the sump at the end of *Harmony Hall*. The other surprise was that we had not seen the main Cheve river since Camp 3. The logistics data shown below indicate that Camp 3, once considered extremely remote, is now approximately half way to the 2021 exploration limit. The map indicates that the largest tunnels discovered this year are sometimes as much as 300 m vertically above the sumps that carry the river. But we were not successful in finding a way down to the river. That remains a great mystery for future exploration.

Following the Wind:

In deep caves it is common to find winds moving through the tunnels. This is driven by atmospheric pressure changes outside the cave entrance. In general the wind inside Cueva Cheve flows towards the deeper tunnels. That is, it pulls the air inward. The wind just beyond Camp 6 was so strong that it constantly blew a 2-meter piece of flagging

tape horizontally. Such wind implies the presence of vast open areas at much greater depths beyond where the measurement is made. But at the northern limit of exploration the wind suddenly disappeared, indicating that the Harmony Hall chamber is blocked. Water flowing through this area is approximately 4°C warmer than the primary Cheve river at Camp 3 and it flows into a shallow sump. The ground in this part of the Cave is covered in mud, suggesting that it has flooded in ancient times. A few hundred meters before the end there is a junction and the tunnel there continues to the west and carries at least part of the wind into a complex upper level maze. We investigated this area for two weeks in April, but were unsuccessful in finding a route leading deeper. This is another great mystery because according to our current data, Cueva Cheve should descend almost 1,200 m vertically from the exploration limit in 2021 to the bottom of Cueva Charco, which is located at a point only 5 kilometers away, indicating a very steep descent.

Airbender Canyon:

During the early stages of the expedition two separate teams, one based from C1 in Cueva Cheve and a second, based from Camp Cartman in Cueva de la Peña Negra, attempted to locate an alternate, dry, route between these two camps that did not involve traversing the wet and windy route below *Saknussemm's Well*. The *Salmon Ladders*, *Turbines*, and *Sumplands* sections of Cheve are notoriously hypothermic and so an effort was made to locate a dry bypass that would form a new "trade route" to C2 in Cheve, via the large dry tunnels in Peña Negra. We had reason to believe such a route might exist based both on the geology (which is highly fault / fracture controlled) and the discovery of the *Tres Amigos* dome in Peña Negra that seemed to be heading north-west towards C1 in Cheve with less than a 400 meter horizontal gap separating them and only a 70 m vertical difference. A 60 meter aid climb up the *Tres Amigos* dome led to a tight fissure where the waterfall entering the room originated. Better success was had investigating the breakdown zone at the top of *Saknussemm's Well*. This led to a

CUEVA CHEVE		Traverse Statistics, Elevations, and Depths								
START	DESTINATION	Segment Traverse Length (m)	Total Distance from Cheve Entrance to Destination (meters)	START elevation (m asl)	DESTINATION elevation (m asl)	Destination Depth below Cheve main Entrance (m)	Destination Depth below highest Entrance (m)	Vertical Change (m) [start to destination]	Average Traverse Time (hours)	Notes
Entrance (Cheve)	C1	1,183	1,183	2692.48	2303.96	389	555	389	1-3 down / 1.5-4 up	traditional Cheve warmup trip
C1	C2	2,338	3,521	2303.96	1890.24	804	970	415	3-5 down / 3.5-6 up	C2 can be reached in one long day from entrance
C2	C3	2,767	6,288	1890.24	1675.67	1,022	1,188	218	5-8 both directions	C3 is one long day from C2
C3	C5	1,291	7,579	1675.67	1659.37	1,033	1,199	11	4-8 both directions	involves a 500 m breakdown crawl
C5	C5.5	591	8,170	1659.37	1680.94	1,012	1,177	-22	2.5 inbound / 1 outbound	involves approximately 150 m of crawling
C5.5	C6	1,310	9,480	1680.94	1510.75	1,182	1,347	170	4-6 both directions	via Prison Break bypass
C6	C7	2,171	11,651	1510.75	1343.65	1,349	1,515	167	2.5 to 4 both directions	includes Deja Thru breakdown (100 m)
C7	Exploration Limit 2021	123	11,774	1343.65	1322.36	1,370	1,536	21	20 minutes both directions	1/3 of distance is chest deep wading

Table 2: Traverse statistics for Sistema Cheve as of June 2021

Table 3 (right): 2021 Cheve expedition personnel, organized by the time each person committed to the expedition.

popcorn-encrusted, multi-level fissure that headed southeast, towards *Tres Amigos* dome. This new tunnel, called *Airbender Canyon* due to the strong air flow, currently ends at a tight fissure just 40 meters horizontally and 50 meters vertically above the limit of exploration in *Tres Amigos* dome.

Surface Recon:

Significant efforts were devoted to reconnaissance in the San Miguel Santa Flor zone with the goal of finding a potential “back door” to the extremely remote areas at the current limit of exploration in Cueva Cheve. Numerous entrances were investigated, most proving to be single pits with plugged bottoms, or locations where active streams disappeared into unseen cracks in the valley floor. Exploration work was continued at Cueva Palomora and, as well, a lightweight recon trip was made to Camp 2 in Cueva Charco after an 18 year hiatus. Plans are currently underway to continue this search effort in 2022.

Logistics and future exploration of Cueva Cheve:

The establishment of Camp 7 in Cueva Cheve represented an unprecedented event in cave exploration. Camp 7 is 12 kilometers from the nearest entrance. Getting there, with a full haul sack, represents a 5 day one-way trip for a normal, fit expedition caver. The problem of working in this place, then, is the logistics of food and equipment resupply. While it may at first seem that this is just like a backpacking trip and that one could go “alpine” and carry all your own food, a quick calculation shows that a fit, acclimated caver would need to haul three 15 kg packs of food, in addition to their camping kit (sleeping bag, pad, space

	First Name	Last Name	Country	Time on Site (weeks)
1	Reilly	Blackwell	USA	14
2	Gilly	Elor	Israel	14
3	Mike	Frazier	USA	14
4	Mary	Hicks	USA	14
5	Sean	Lewis	USA	14
6	Colin	Magee	New Zealand	14
7	Adrian	Miguel-Nieto	Mexico	14
8	Amy	Morton	USA	14
9	Vladimir	Paulik	Slovakia	14
10	Thomas	Polson	USA	14
11	Bill	Stone	USA	14
12	Michael (Mowgli)	Swartz	USA	14
13	Jordan	Toles	USA	14
14	Kasia	Biernacka	Poland	12
15	Jeremy	Bruns	Canada	12
16	Kathleen	Graham	Canada	12
17	Max	Koether	Canada	12
18	Pablo	Durana	USA	10
19	Yazmin	Barragan	México	8
20	Claudio	Cruz Garcia	Mexico	8
21	Sonia	Dudziak	Poland	8
22	Witold	Hoffmann	Poland	8
23	Bev	Shade	USA	8
24	Rafal	Sieradzki	Poland	8
25	Dave	Stone	USA	8
26	David	Tirado	Mexico	8
27	Corey	Hackley	USA	6
28	Gerardo	Morrill	Mexico	6
29	Hazel	Barton	UK	5
30	Kristen	Anderson	USA	4
31	Oscar	Berrones	Mexico	4
32	Victor	Bravo	México	4
33	Derek	Bristol	USA	4
34	James	Brown	USA	4
35	Adam	Byrd	USA	4
36	Raul	Calderon Martinez	Mexico	4
37	Allan	Cobb	USA	4
38	Chelsea	Dau	USA	4
39	Ben	Dau	USA	4
40	Mark	Dickey	USA	4
41	Stephen	Gladieux	USA	4
42	Rob	Gowler	USA	4
43	Elliot	Guerra-Blackmer	USA	4
44	Mikolaj	Harasimowicz	Poland	4
45	Judit	Kovacs	Hungary	4
46	Johanna	Kovarik	USA	4
47	Jean	Krejca	USA	4
48	Alejandra	López - Portillo	Mexico	4
49	Abigail	Mack	USA	4
50	Cait	McCann	USA	4
51	Sonia	Meyer	USA	4
52	Abraham	Miguel	México	4
53	Aria	Mildice	USA	4
54	Ramses-Alejandro	Miranda-Gamboa	Mexico	4
55	Josh	Moor	USA	4
56	Cassandra	Mosley	USA	4
57	Denes	Nagy	Hungary	4
58	Erika	Olvera Garcia	Mexico	4
59	Linda	Palit	USA	4
60	Kara	Posso	USA	4
61	Ron	Rutherford	USA	4
62	Philip	Rykwald	USA	4
63	Georgia	Schneider	USA	4
64	Bryce	Smith	USA	4
65	Tristan	Stahl	USA	4
66	Jessica	van Ord	USA	4
67	Gustavo	Vela	Mexico	4
68	JJ	Kelley	USA	2
69	Andy	Maser	USA	2

blanket, dry clothes, and personal items), in order to spend 2 productive days exploring from Camp 7. The round trip would constitute 30 days underground and this assumes the rigging to already be in place. The alternative is the approach used in 2021 in which support crews, generally with less time available and with less experience, undertook the task of moving food and equipment from basecamp to C3. This was a near continuous conveyor belt throughout the expedition. Most people with longer stay times on the expedition spent their first 10 days underground moving supplies down to as far as C5.5 before a slot became available for them to move on to C6. This support pipeline is, in essence, a pyramid: 30 people work for ten days to allow a team of four to stay for 6 days at Camp 6. If something simple is missing – like cheese, or rope, coffee, or batteries for lights – it would take 7 to 10 days to move things from basecamp to Camp 7. And this time estimate takes into account that we had the advantage of a phone system that reached up to Camp 6.

As a result of this remoteness, 2021 marked the longest trips ever made inside Cueva Cheve, and, in fact, the longest active subterranean push durations conducted in any cave on Earth. In the past, 10 to 14 days was considered a long push in the cave. The average for those working beyond Camp 6 this year soared to between 25 to 30 days without seeing sunlight. These realities indicate that we are reaching a situation almost impossible to sustain. Maybe we could continue the same practice and support long duration teams at C7. But what happens at C8 or C9 ?

The practical implication, even in 2021, was that we could not investigate all the possibilities to find the continuation of the cave beyond *Harmony Hall* because the places to investigate are so far from the last camp. Currently it is a six hour round trip hike from Camp 6 just to reach locations of potential interest. The final pushes of 2021 were approaching 20 hours duration. A return expedition will need to find ways to reduce the weight of food and equipment by a factor of 2 or more to allow further exploration.

New Technology:

The Cheve project has, for 15 years, used single wire earth-conducting communications to coordinate underground camp activities. For 2021 electrical engineer Brian Pease designed a completely new telephone system (the *Pease UltraFone*) that produced clear conversations as far as 12 kilometers from basecamp. In 2019 Kristen Anderson designed a prototype modem to enable the transmission of data using the Cheve phone line. Brian Pease advanced the concept further to produce the 2021 *SWiM* (single wire in-cave modem) units that were used by the expedition for digital file transfer between all underground camps and basecamp. For the most part, the expedition used the OLIVIA_16_2000 modem protocol. Olivia 16-2000 uses 16 audio tones (one at a time). It uses 2000Hz of audio bandwidth (500-2500Hz) at 125 baud, which is 80 Words/minute. Although slower than MFSK, it worked reliably as far out as C6. We routinely uploaded digital survey data not only to basecamp, but also to other underground camps so that they could make use of the data to direct exploration if passages were converging towards one another. The expedition also successfully used a small generator at C3 for recharging drill batteries. This turned out to be more than three times as efficient, in terms of total weight transported, as bringing extra batteries in from the surface.

Expedition safety and COVID19:

The expedition took place at the height of the COVID19 pandemic. Extensive safety precautions were developed over the 8 months leading up to expedition departure. The protocols we developed are given [here](#). These were rigorously implemented in the field with the result that not one person on the expedition became sick. We feel, therefore, that the protocols developed for Cheve may be of future use to expeditions that may take place under similar circumstances (e.g. a particularly virulent flu season coinciding with the expedition dates). Similarly, despite numerous day-to-day injuries that can be considered “normal” for a multi-month, intense caving expedition (including two dislocated shoulders, many hand, and knee injuries, as well as severe cases of trench foot, all of which were resolved through self-rescue) there were no serious accidents nor fatalities. We attribute this mostly to two things: regular team briefings, and personal advising, regarding the benefits of not overloading and not traveling for speed; and the presence of a complex, difficult rebelay course in basecamp that tested each individual on every rigging variation in the cave prior to authorizing anyone to go into the cave.

Acknowledgements:

No endeavor on the scale of an international expedition can take place without the help of many people in addition to the expeditionary team. We are grateful to the following companies who helped to provide the expedition with the specialized equipment and food necessary for such a complex technical project:

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Bill Stone
Austin, Texas
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