HONDURAS, CENTRAL AMERICA:

A BRIEF REVIEW of its

SPELEAFERS, its CONGLOMERATE CAVES,

the 2009 SPELEOSPHERE POZO del PORTILLO EFFORT,

and the SPELEOLOGICAL POTENTIAL of the

MONTAÑA de la FLOR STRUCTURAL BELT

In Central America, the Republic of Honduras is second only to Guatemala in caves and karst resources. The best known speleafer in Honduras is the Aptian-Albian (mid-Cretaceous) Atima Formation, a limestone unit first described by Mills *et al.* (1967), who named the formation after the *pueblo* of that name and the nearby Río Atima. Mills *et al.* noted that the Río Atima entered a large cave near the Atima type section, to resurge 1.5 to the north, on the opposite side of a mountain ridge. This casual statement was probably the first mention of this great river cave in an English publication. Other early mentions of caves in Honduras are primarily found in archeological reports, with little description of speleological aspects.

The Atima Limestone Speleafer:

The Atima Formation is the most widespread carbonate unit in Honduras, with many exposures from the Guatemalan border on the west to the Nicaraguan border on the east. It hosts Honduras' most spectacular karst zones: the great Montañas de Colón fold and thrust belt of intensely karstified Atima, and the Montaña de Santa Bárbara block of high karst.

Not surprisingly, the Atima limestone hosts most of Honduras' best caves, including Honduras' longest and deepest known caves: Cueva Quebrada Susmay, 6359 m long (Hawkins and McKenzie, 1993; Sivelli and De Grande, 1998; Sivelli, pers. com., 2010); Sumidero Maigual, -420 m deep (Knutson, 1981). Other significant Atima caves include Cueva del Río Talgua, famous as the "Cave of the Glowing Skulls" (3090 m L; Cohen, 1986; Brady *et al.*, 1995a and 1995b), Sumidero del Río Atima (2450 m L, -190 m D; Knutson, 1986; Knutson, 1988), Cueva La Buena Fé (353 m L, -160 m D; Finch, 1983), and Cueva Guatemalía (242 m L, -330 m D; Finch, 1991). In addition, the known, but inaccessible, subterranean Río Zacapa drainage over nine kilometers in length (Finch, 1972; Bogle, 1982; Finch, 1983) is developed in the Atima.

The Atima limestone is typically thick-bedded, dark grey micrite, commonly fossiliferous, highly soluble, and an excellent cave host. Its stratigraphic thickness enables caves of significant horizontal and vertical extension to develop in it.

Republic of Honduras. Montaña de Santa Bárbara high karst is located just north of the name Santa Bárbara (west central Honduras); Montañas de Colón karst belt lies between the Río Patuca and the border with Nicaragua (eastern Honduras). Town of El Rosario and Pozo del Portillo cave are located between the towns of Salamá and Yoro (central Honduras).

The thickness of the Atima limestone varies greatly, with reported thicknesses ranging from 90 m to a maximum of 1435 m (Mills *et al.,* 1967), with the greatest known thicknesses corresponding directly to the largest karst zones in Honduras, i.e., the Montañas de Colón and Montaña Santa Bárbara areas. The thickness variations are real, and in some places due, at least in part, to erosion of the upper Atima prior to deposition of the overlying Valle de Angeles Group of mainly redbed clastic strata (Rogers *et al*., 2007). Nonetheless, some of the thickness variations reported by Mills *et al*., (1967) resulted from their having mistaken for Atima limestone a second limestone unit, very similar in appearance to the Atima, but in reality stratigraphically above the Atima and separated from it by a section of redbed clastic strata belonging to the Valle de Angeles Group.

The Cenomanian Limestone Speleafer:

The second noteworthy speleafer in Honduras is a limestone unit within the Valle de Angeles Group. This limestone was shown to be of Cenomanian age (early Late Cretaceous) and named the Jaitique Formation (Finch and Curran, 1977; Finch, 1981). It is very similar in outcrop appearance to the Atima limestone, i.e., generally consisting of thick-bedded grey micrite, but it does not achieve the great thicknesses common to the Atima, probably never exceeding 250 m thickness and being more commonly around 100 m. Nonetheless, it is an excellent limestone for caves, hosting caves such as Grutas de Taulabé (Honduras' best known commercial cave, only partially mapped to a length of 921 m; Miller, 1981), Cueva Siete Quebradas (Honduras' second longest cave at 3258 m L, and featuring a thermal stream; Hawkins and McKenzie, 1993; Finch, 2009 and unpub. data), Cueva Quiscamote (Finch, 1982), Cueva Los Olivos (Finch, 2008) and numerous others.

The Jaitique Formation is one of several Cenomanian limestone units in Honduras, including the Esquías Formation (Horne *et al*., 1974) and the Gualaco Formation (Rogers *et al*., 2007). Because these limestones are believed to have been laid down in separate depositional basins, they are considered separate formations.

Lithologic differences among the formations no doubt result in different speleological potential for the Cenomanian limestones. Thus far the Jaitique Formation has more reported caves than the other Cenomanian units. Nonetheless, it would be reasonable to generalize to the point of saying that areas of Cenomanian limestone are scattered across central Honduras and together form the second most important speleafer in the republic.

The Limestone Conglomerate Speleafer:

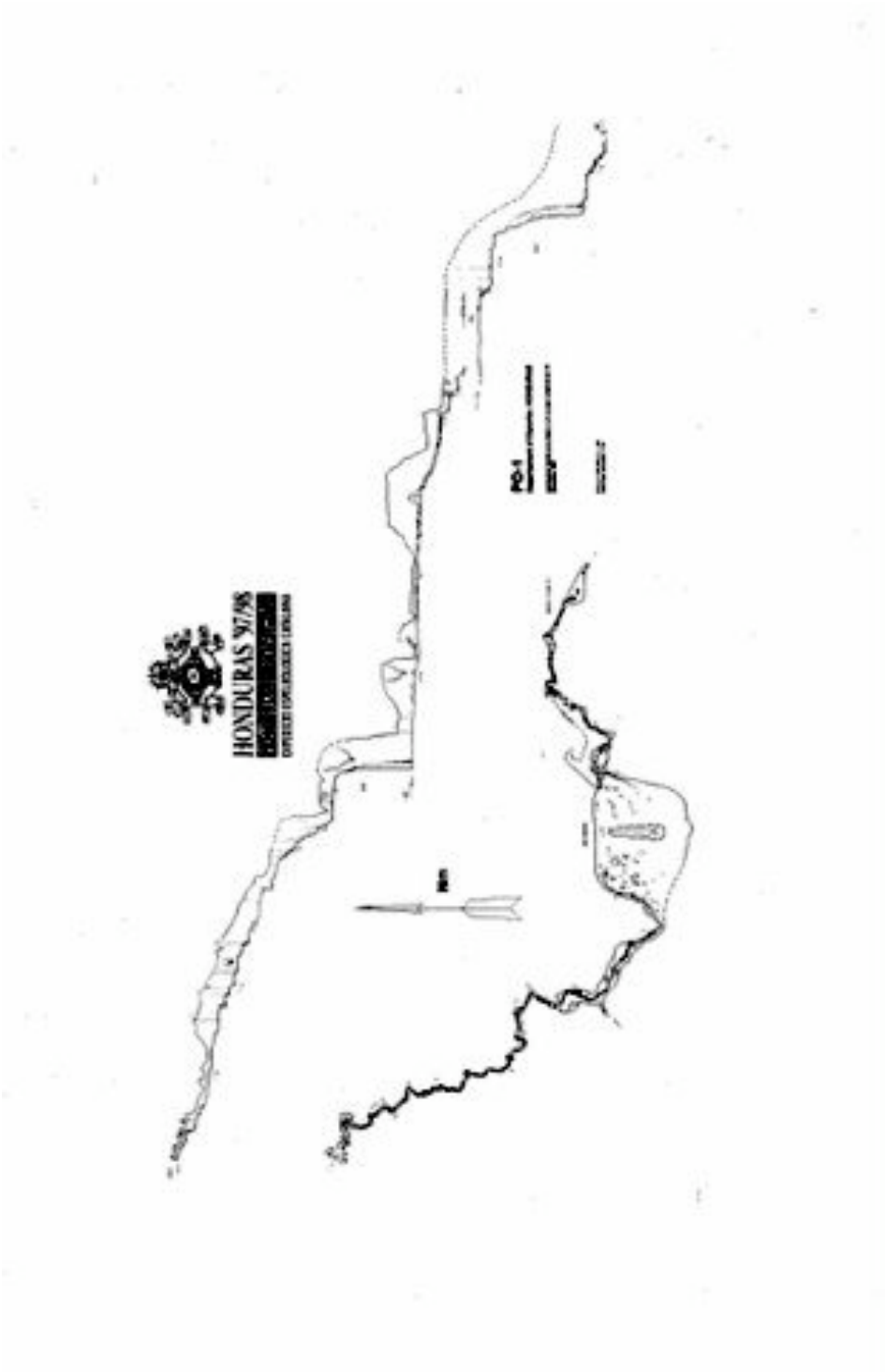
In the late 1990s, dramatic discoveries made by Catalan cavers revealed a third significant and highly unusual speleafer in Honduras: limestone conglomerate units in the Valle de Angeles Group. Although the late Cretaceous Valle de Angeles Group consists predominantly of redbed clastic strata (quartz-pebble conglomerate, and red-colored sandstone, siltstone and shale), prominent conglomerate units consisting of limestone clasts in a reddish matrix of silt or sand have also been widely reported (Mills *et al*., 1967; Finch, 1972; Finch, 1981; Southernwood, 1986; Rogers *et al*., 2007). These conglomerates were evidently shed into Valle de Angeles depositional basins from adjacent uplifts of Atima Limestone (and possibly uplifted blocks of Cenomanian limestone) to be intercalated with the red clastic strata of "normal" Valle de Angeles deposits (Rogers *et al*., 2007). Where the limestone clasts comprise the majority of the rock, the conglomerates are compositionally limestone units, subject to karst processes just as any other limestone.

To date, Honduran caves of significant length and depth formed in limestone conglomerate are known only from a relatively small area near El Rosario, Dept. of Olancho. However, the known caves include the deepest cave in the world in conglomerate, -384 m D (Anonymous, 1998) and the area's potential has barely been scratched by the two groups of Catalan cavers, one group of Italian cavers, and two groups of American cavers who have visited here.

In September 1997, twenty cavers from the Federació Catalana d'Espeleologia discovered and explored Cueva del Resumidero, a sub-horizontal, active resurgence cave developed in limestone conglomerate, which they mapped to a terminal siphon at 960 m from the entrance. They also discovered and partially explored a multidrop cave in conglomerate they named Pozo del Portillo, which they mapped to a depth of -232 m below the entrance, with going cave left unexplored. At the end of the 1997 explorations Pozo del Portillo had been mapped to a length of 650 m and occupied second place for world depth records in caves excavated in conglomerate (Pauné, 1997, and Anonymous, 1998).

A third conglomerate cave, an active *sumidero* named Sima Dolina Norte-1 was explored to a depth of 70 m. This cave is situated in a doline reached only after three days of trail cutting by machete (Pauné, 1997). The 70 m depth is to the bottom of the entrance shaft, with cave beyond left unexplored due to lack of time (pers. com, 2009, from Josep Guarro, member of the 1998 expedition).

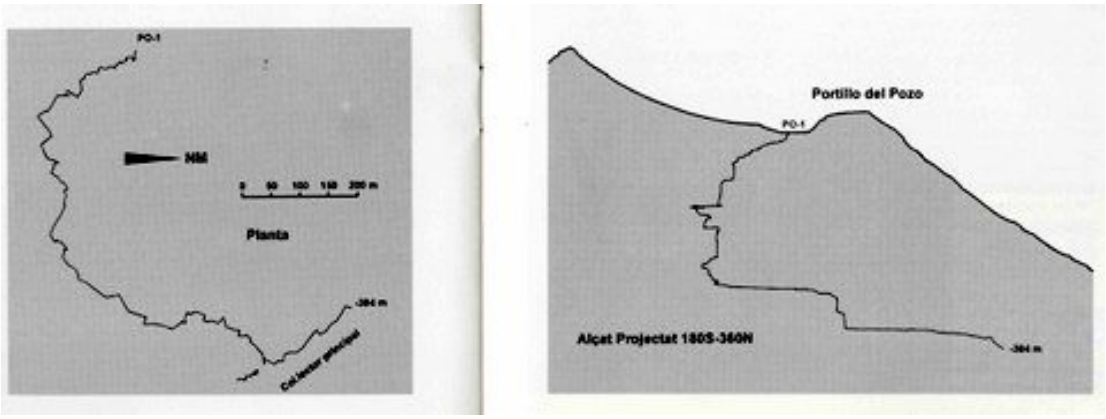
The following September, a second Catalan expedition, consisting of 11 explorers, returned to Pozo del Portillo, to continue the work started in 1997. According to Guarro, at a depth of -346 m the small cave stream they had been following was joined by another major stream of perhaps three times the volume of the entrance stream. Beyond this they entered a boulder-choked hall where they reached the top of a 10-15 m drop, at which point exploration was halted some 100-200 m beyond the last survey station (Guarro, pers. com., 2009), According to their published report, they mapped the cave to a length of 1400 m (with an additional 600 m explored), and down to a depth of -384 m, making Pozo del Portillo the deepest known cave in



Map and profile of Pozo del Portillo, Catalan expedition 1997 (Anonymous, 1998)

the world developed in conglomerate*, and the ninth longest (Anonymous, 1998). Unfortunately, the 1998 group felt obliged to call off exploration before bottoming the cave. Leaving the cave fully rigged, they abandoned their camp abruptly. The cause of this hasty retreat was a violent local happening involving gunplay, with members of the expedition group caught up in the scene. Also unfortunate is the fact that no finished map was produced by this expedition, only a line plot (Guarro, pers. com., 2009).

*The second longest appears to be China's Longmen Dong Cave, which is of a very different nature, requiring no rope drops, but nonetheless has a vertical extent of 356 m.



Catalan line plot and profile of Pozo del Portillo as of 1998 (Anonymous, 1998)

In addition to the three caves mentioned above, the Catalan cavers report having found 28 other caves, mostly short, but noteworthy as including two with pre-Columbian ceramics (Anonymous, 1998). Their report does not state which, if any, of these 28 caves are developed in limestone conglomerate and which in ordinary limestone, but inasmuch as both rock types are present in the area, it seems reasonable to suppose that at least some of these caves are in each unit. According to Valentí Zapater (pers. com., 2010), who participated in both Catalan expeditions, "as far as I remember all the caves in the Portillo and Montaña Rompeculo zone are in conglomerate." Zapater remembers a single cave in limestone in the Montaña La Cumbre area lying to the SW of Montaña Rompeculo.

Both Catalan expeditions took place in September and rain was significant. According to Guarro, it rained daily in 1998 (Guarro, pers. com., 2009).

In 2001, a group of American and Canadian cavers, led by Pete Shifflett, made a reconnaissance in an area a few kilometers northwest of El Rosario, in the process discovering a minor cave developed in conglomerate. Though the cave apparently drains to a resurgence several hundred meters from the entrance sink, the cave was small and impenetrable after a short distance. Unaware of the fine discoveries made by the Catalans in 1997-98, the group mistakenly concluded that the limestone conglomerate was an unlikely host for major caves and moved on (Van Ieperen, 2002; Finch, 2006).

In 2008, a small contingent of Tennessee and Ohio cavers, led by Ric Finch, made a brief recon into the El Rosario area. Having learned of the Catalans' discoveries, this group wanted to check out the situation for a possible future attempt to bottom Pozo del Portillo. Finch relocated the entrance to Pozo del Portillo and the group explored a resurgence cave with a location that made it an obvious possible resurgence for the deep Pozo del Portillo. Having no location information for the Catalans' Cueva del Resumidero, this group assumed that they had located the Catalans' cave. The fact that this cave had no swimming section near the entrance as described by the Catalans was attributed to their having made their explorations during the rainy season, whereas the 2008 group made their recon during April, one of the two driest months of the year. Planning commenced for a return trip the following year. One of the first steps was to ascertain whether or not the Catalans had any plans to return to Pozo del Portillo. Ric managed to contact three of the Catalan expedition members and was informed that they definitively did not plan to return. Josep Guarro was extremely generous, providing survey data, and sharing much valuable information not available in the published articles on Pozo del Portillo.

The 2009 Speleosphere Expedition to Pozo del Portillo:

For 2009, Finch organized a group of cavers to return to Pozo del Portillo and attempt to finish the exploration and mapping to its bottom. The group, sponsored in part by the National

Speleological Society through the Speleosphere Project, included Finch, Matt Oliphant, Nancy Pistole and Pete Shifflett (members of the 2001 group), Mary Gratsch and Pete Miller (members, along with Finch, of the 2008 party), plus Gary Dunkley and Costa Rican caver Andrés Ulloa. Several other invited cavers unfortunately were not able to join us, so our group never achieved the strength we had wanted for the planned undertaking. In addition to finishing off Pozo del Portillo, our group intended to dye trace the deep cave stream to its presumed resurgence cave located in 2008. We scheduled our effort for late March – early April of 2009, at the height of the dry season.

March 26: We arrived at the town of El Rosario, armed with a *constancia*, i.e., official letter of introduction, a very useful document to have in order to avoid problems with local officials. Our *constancia* was from the Director of the Honduran Institute of Anthropology and History in the capital, Tegucigalpa. We took lodging in the small, but adequate, Hotel El Costeño, which we had reserved in advance, as our group needed all but one of their rooms.

March 27: Ric visited with the local *alcalde* (mayor) and chief of police to inform them of our plans. While this "politicking" was being done, part of our group went with Dagoberto Juárez, our local guide and "man Friday", to set bugs (activated charcoal dye receptors) in the presumed resurgence for Pozo del Portillo, explored by the 2008 group.

March 28: We drove out to the village of El Ocotal, where Dagoberto ("Dago" for short) was awaiting us with the six mules and muleteers necessary to take our gear up to Pozo del Portillo. Unfortunately, we were accompanied to El Ocotal by a large police escort, which we neither requested nor wanted. Ostensibly for our protection, the heavily armed contingent seemed mainly to be out for a noisy lark. At one point the police chief had said he would send two officers up to the cave with us, "to protect us from bandits", but to our relief none of the uniformed men actually came with us (far too much work!). It should be noted that while it is necessary to maintain good relationships with local authorities, we had no control over the police actions, but were well aware that being accompanied into a small village by an armed posse is not the best way to inspire confidence with the local people. It is fortunate that we had Dago, a well-known and respected local, working with us. Dago also worked with the Catalan explorers in 1998 and definitively is the man to see to get things done when caving in this area; he knows the area and he is smart and dependable.

A small portion of our police escort watching Dagoberto as he readies the mules. Photo by Gary Dunkley.

Pozo del Portillo ("Pit of the Pass") is reached by a two hour walk from El Ocotal, starting at an elevation of 800 m at El Ocotal and climbing up to around 1350 m. The cave is located in a sink shown in kilometer square 27/42 on the Yocón 1:50,000 quadrangle, and indicated by closed

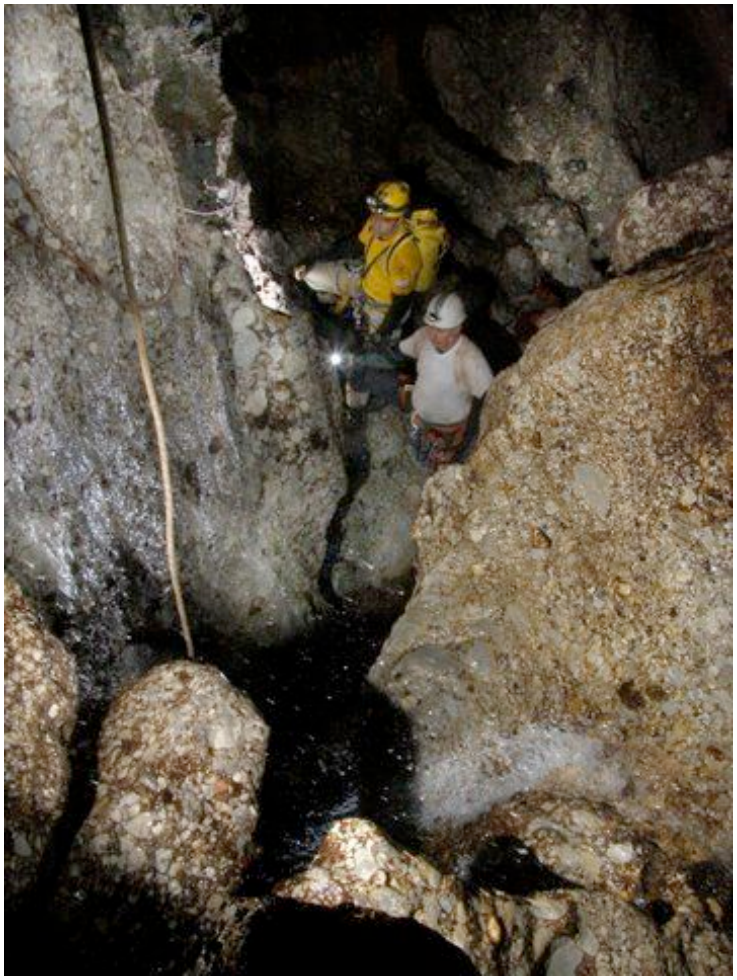
contours of 1340 and 1320 m in the immediate vicinity of a trail that goes through the pass identified on the map as Portillo del Pozo ("Pass of the Pit"). It is close to the hilariously named Montaña Rompeculo, literally, "Break-Ass Mountain". Some of the older members of the 2009 group will aver that hiking up to Pozo del Portillo in the blazing heat of the dry season is a bust-ass hike! A number of GPS readings were taken near the entrance, and averaged to give the following location coordinates: 0527203 and 164194 at an approximate elevation of 1324 m

An excellent campsite is found in the entrance sink, just off the major trail that passes through the *portillo*. While convenient for accessing the cave, this trail, being in frequent use makes it mandatory that someone remain in camp at all times to prevent pilferage; we rotated the duty of camp guard. The small (in the dry season) stream flowing into the cave is apparently permanent, and is a good source of water for the camp. By the end of the day we were settled in camp and Matt had already rigged the entrance drop and a couple of drops beyond.

One hazard future explorers must be on the lookout for is venomous snakes. Our group found one pit viper (how appropriate!) in the entrance to Pozo del Portillo, saw a large *barbamarilla* (fer de lance) beside the main trail the first night in camp, and later saw two other unidentified snakes. The owner of the Pozo property had a child badly injured by a *barbamarilla* in this vicinity.

Entry into Pozo del Portillo cave is through a chaos of large boulders of limestone conglomerate, leading to the first drop (actually climbable, but safer rigged) which is in this chaos, prior to actually entering cave in solid bedrock.

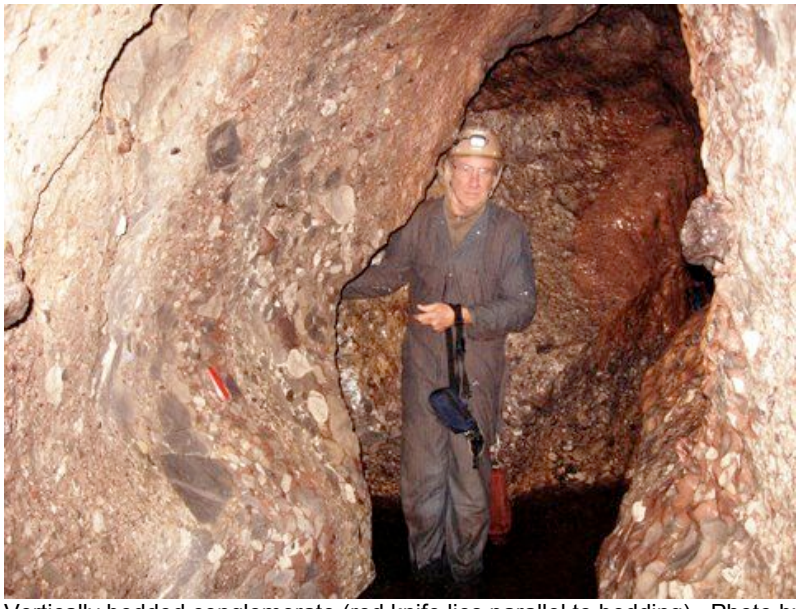
Mary in the boulder chaos at the entrance to Pozo del Portillo. Photo by Ric Finch.


Andrés and Pete M. at the bottom of the entrance boulder chaos drop. Photo by Mary Gratsch.

Once into bedrock, the cave becomes sinuous and very narrow (commonly 0.5 to 1 m wide) as it passes through a section dubbed “the meanders” by the Catalans. Walls of smoothly eroded conglomerate present a fascinating, gorgeous and very photogenic mosaic.

The bedrock hosting Pozo del Portillo consists of a grey limestone conglomerate. The limestone clasts are generally well-rounded, pebble to cobble-sized (occasionally boulder-sized), tightly cemented in a reddish to dark reddish-brown silty-sandy matrix. It is a clast-supported conglomerate, the clasts comprising the great majority of the rock. Five point-counts, three from Pozo del Portillo and two from Cueva Resumidero del Pozo (described later), gave 49 to 79 % (avg. 69%) limestone clasts, 0 to 4 % (avg. 2%) non-limestone clasts, and 20 to 46% (avg. 29%) matrix. Hence, except where limestone clasts comprise less than 50% of the rock, the conglomerate is compositionally a limestone. These limestone conglomerates are subject to karst solutional processes just like any normal limestone.

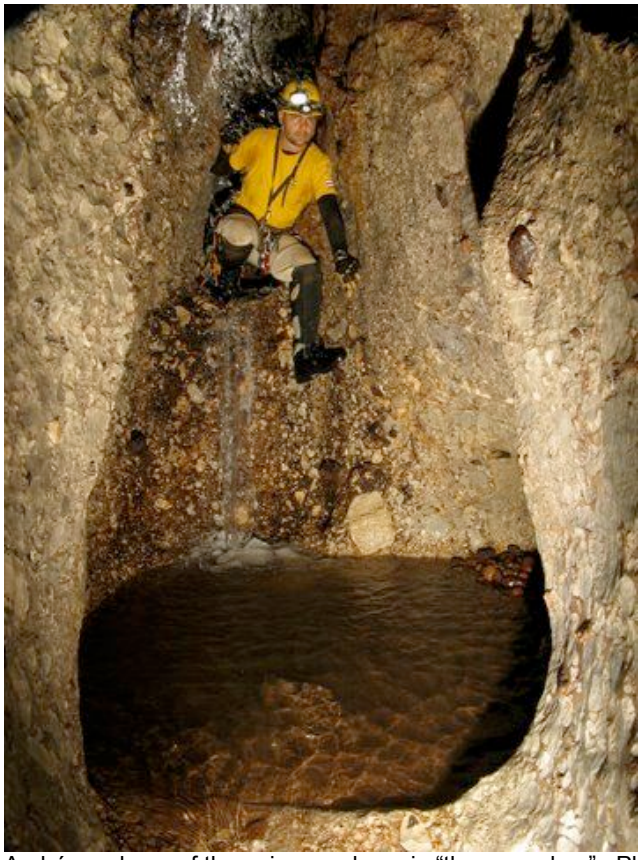

Ric examining well-rounded conglomerate bedrock. Photo by Mary Gratsch.


Vertically bedded conglomerate (red knife lies parallel to bedding). Photo by Mary Gratsch.

The bedding is not easily seen, but was detected in several places and found to be vertical to sub-vertical, and striking 295 – 305 degrees, an orientation that approximates the linear trends of the strike ridge topography in this area.

Due to its tightly cemented nature, the limestone conglomerate is very solid and takes bolts well, with little tendency for individual clasts to pull out. This is fortunate, inasmuch as the smooth nature of the water-solutioned walls makes natural anchors scarce.

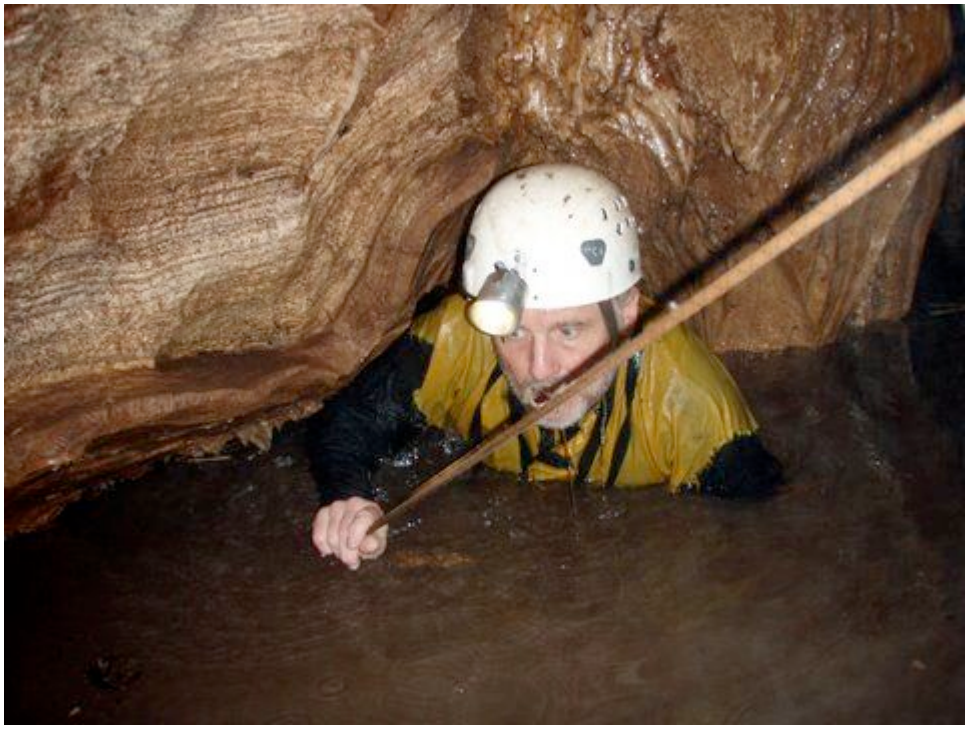
The meanders section drops rapidly through a series of small nuisance drops, some of which are climbable, and some of which must be rigged. We noted that where we found remnants of the Catalan rigging, it was placed higher than our rigging, apparently indicating the greater water flow they encountered in their September explorations.



Andrés and one of the nuisance drops in “the meanders”. Photo by Matt Oliphant.

March 29: On the first full day working in the cave, at a depth of about 85-90 m the first major pitch, the Catalan’s 41 m drop designated “P-41” (for “pozo 41 m”) was reached and descended. Here the cave stream forms a waterfall tumbling down into the pit, which bells out to perhaps 10 m in diameter. Matt rigged this drop with a rebelay and a re-direct, to keep the rope free from contact with sharp edges, but part of the rappel was in the waterfall.

A short distance beyond the P-41 the ceiling abruptly lowers as the Catalan’s “semi-siphon” is reached. Apparently it was a genuine siphon, length unknown, when first explored by the Catalans—we marveled at their audacity at pushing through it…which of them had the *cojones* to make the first attempt? At the time our group arrived it was again completely sumped, and even knowing it was only 2 meters long you still had to screw up your courage to push through…Pete S. was the first to take the plunge. We were able to create a few centimeters of air space by spending an hour digging a trench through the gravel on the downstream side to lower the water level. Our first day of exploration and rigging ended here.


Pete S. emerging from the “semi-siphon”. Photo by Mary Gratsch.

Today Ric remained in camp all day as camp guard, and was on hand to greet Andrés Ulloa, our Costa Rican contingent, who was escorted up to Pozo by Dago, bringing our group strength up to eight cavers.

March 30: While Mary remained in camp as camp guard (along with Andrés, trying to get over a cold) the rest of our group entered Pozo. Unfortunately, upon reaching the P-41 Gary had to turn back, having accidentally left his pack higher up in the cave. Matt, not satisfied with yesterday’s rigging, re-rigged the P-41, adding a second redirect to move the rope out of the waterfall. Once past this drop, our group of five spent a second hour trenching beyond the “semi-siphon” and managed to lower the water until it was merely an ear-dipper.

A short distance further in we came to the largest room in the cave, the “Sala Catalunya”, measured by the Catalans at 55 X 65 m, with a ceiling height reported as 25 m. What appears on their map to be a gigantic breakdown block in the center of the room is actually an immense mass of flowstone. The cave stream disappears amid the various large blocks in this room, and the way on was not immediately obvious. At this point Ric --who had found his long rack and other rather aged vertical gear not really appropriate for passing rebelays and redirects-- decided to return to the surface, accompanied by Pete Miller, while Matt, Nancy and Pete Shifflett continued on in. Ric gave them the can containing about a kilogram of fluorescein dye, to inject into the cave stream before they started back up. They found the way on, reached the second major drop, the “P-48”, descended about half way down this broken pitch, where they decided to call it a day. They dropped the dye in the stream at the top of the P-48, approximately 175 m below the entrance, at 5:20 PM, Mar. 30, then headed back to camp, which they reached around 7:30 PM.

March 31: Matt and Nancy hiked back to El Ocotal and on in to El Rosario to recharge Matt’s drill batteries and drive to the next town to check e-mail, returning to camp just before dark. During their absence Pete M., Mary, and Ric did photography in the upper part of the cave. And Gary took Andrés into Pozo and watched him drop the P-41. Inasmuch as Andrés was at that time a stranger to us, it seemed prudent to “check him out”…he passed with flying colors, being young, strong, and adept. As Ric later told Matt, “he’s a keeper”. Pete S. remained topside as camp guard.

April 1: Today our cave team was reduced to just six: Gary declined to continue into the cave due to some muscle or joint pains, and Ric concluded that his equipment and experience

level were not adequate to continue in without possibly risking an accident, something to be avoided here at all costs. The six split into two teams, with Pete M., Mary and Andrés entering at 8:45 AM and the second team consisting of Matt, Nancy and Pete S. going under around 9 AM. The plan was for the second team to bypass the first and continue finding the way in and rigging it, while the first team came along mapping. Gary was assigned camp guard duties, while Ric went to look for the entrance to the Catalans' Cueva del Resumidero, using a GPS unit and their published coordinates.

Ric's eight hour hike took him by the entrance to the presumed resurgence for the Pozo del Portillo cave stream and wow did we have a positive dye trace! The water was a bright green. No need for lab analyses of any charcoal receptor! But a potential undesirable consequence of this wildly colored water was what effect it might have on any locals who saw it…a matter that would soon be made abundantly clear.

A very positive dye trace at Cueva Resumidero del Pozo. Photo by Ric Finch.

Ric followed the resurgence stream to where it joined the "main" streambed shown on the map, but this was bone dry upstream from the resurgence stream. Following this dry stream west, upstream towards the Catalans' Cueva del Resumidero, a little before 2 PM Ric was standing in a corn field where his GPS unit matched the Catalans' coordinates for El Resumidero. No cave here! A possible wet weather resurgence was located near the base of the mountain flank near by, but no obvious candidate for Cueva del Resumidero. A mystery remained, but the hour required that Ric head back to camp.

En route back up the mountain, Ric met the owner of the Pozo area who was rather worried about the green water coming out of his spring and what effects it would have on his cattle. Fortunately, he was a reasonable man and accepted Ric's explanation that the dye was harmless and would soon disappear. A donation for his child's hospital bills also helped smooth his upset. In the meantime, back at camp, Gary, who speaks only a little Spanish, was having a harder time calming down a large group of angry and armed *campesinos* who had come up to camp to demand our immediate departure from the area. By the time Ric arrived at camp Gary had done a good job of making friends and entertaining them, but it had taken several tense hours to do so. Nonetheless, Ric had to go through all the explanations about the dye, its purpose and harmlessness, again for this group, which finally returned to El Ocotal. A lesson to be learned here: try not to use too much dye, and let the locals know what is being done beforehand…just in case!

To top off an event-filled day and a somewhat negative one at that, while Gary and Ric were eating supper in camp, Pete M., Mary and Andrés unexpectedly returned to the surface with the news that Matt, after conferring with Nancy and Pete S., had called off the exploration effort and had begun derigging. It seems Pozo becomes more difficult below the P-48 drop and safety had become a real concern: the group was too small to safely field two working groups, and in the event of an accident, rescue would be extremely difficult. Matt, Nancy and Pete S. derigged up to the top of the P-41 before exiting.

Thus ended the effort to push beyond the explorations of the 1998 Catalan group and to finish the mapping. However, all agreed that safety trumped exploration.

April 2: Gary and Pete S. went in to finish derigging, while Matt and Nancy took photos using Andrés as a model. Ric took guard duty in camp again, and later in the day walked out to a point where cell phone reception could be had, to call Dago and tell him seven mules would be needed for packing out camp the next day.

April 3: Our reliable friend Dago arrived early in the morning, having left his house in El Ocotal at 5 AM, worried that some of the locals upset about the green water might be causing us problems. And the mules arrived shortly after he did. By mid-morning everyone and all the muleloads of gear had made it not only back down the mountain to El Ocotal, but from there by car back to the Hotel El Costeño in El Rosario, a minor miracle of transportation logistics, but a good thing, because Ric had to drive Pete M. and Mary into the airport in San Pedro Sula—five hours of hard driving—this same day.

April 4: Today, Nancy, Matt, Pete S., Andrés, and Gary mapped the resurgence cave, which we decided to name Cueva Resumidero del Pozo, in order to distinguish it from the Cueva del Resumidero of the Catalans. The cave mapped out at 374 m long, gaining 23 m elevation, to end at a terminal sump. The average direction is almost due south, headed right for Pozo del Portillo.

Map and profile of Cueva Resumidero del Pozo, drafted by Nancy Pistole.

While much shorter than Cueva del Resumidero, Resumidero del Pozo is likewise a sub-horizontal active stream cave developed in conglomerate, and very beautiful.


Pete S. negotiating a cascade in Cueva Resumidero del Pozo. Photo by Matt Oliphant.


Nancy in a giant pothole in Cueva Resumidero del Pozo. Photo by Matt Oliphant.

After mapping Resumidero del Pozo, our group went in search of the Cueva del Resumidero, but, like Ric earlier, did not find it. A dark fissure, a possible wet-weather resurgence was located, but no obvious cave. And so the puzzle remains: where is the Catalans' resurgence cave? Is it strictly a wet-weather resurgence (during the 2009 dry season the main streambed in the valley was dry upstream from the stream issuing from Resumidero del Pozo)? And what feeds Cueva del Resumidero, does it have a high entrance, the equivalent to another Pozo del Portillo, perhaps in one of the sinks on the west side of Montaña Rompeculo?

Pozo del Portillo, Resumidero del Pozo and Cueva del Resumidero overlaid on topography.

Another mystery is how the Catalans missed finding Cueva Resumidero del Pozo, inasmuch as it is the best known resurgence in the area, and is permanent, not seasonal. It is possible that in the wet season the volume of water issuing from it might make it impossible to enter the cave. But that is insufficient as explanation because the Catalans state in their 1998 article that they had not located any possible resurgences for Pozo. We hypothesize that they followed the main streambed, which is labeled on the map "Quebrada El Resumidero" and which was flowing in the wet season. By sticking to the main stream they would have by-passed the smaller side stream coming from Resumidero del Pozo, and arrived at a seasonal resurgence that we did not locate in the dry season.

What is clear is that much remains to be explored and discovered in this area.

April 5: We left the area with some regrets about the failure to bottom Pozo del Portillo. We had originally hoped to finish the map started by the Catalans, push the world's depth record for caves in conglomerate past the 400 m mark, and perhaps even establish a new depth record for caves in Honduras. Nonetheless, we were pleased to have had the privilege of seeing a portion of a spectacular cave in conglomerate, to have proven where Pozo resurges, and to have mapped a new cave, Cueva Resumidero del Pozo. And we certainly had no regrets about leaving the dusty, unpleasant little town of El Rosario behind. Matt, Nancy and Andrés headed for Guatemala for more caving, Gary to the Bay Islands for some fun in the sun, and Pete S. and Ric returned to Tegucigalpa to turn in our rental vehicle and book new flights home. And so the 2009 Pozo del Portillo effort ended.

The Potential for Further Explorations in the Pozo del Portillo System:

Having demonstrated that Resumidero del Pozo is the resurgence for Pozo del Portillo, it is now possible to estimate the full vertical extent of the Pozo system. To do this accurately, of course, depends on having reliable elevations for the two entrances, simple in theory, but

unfortunately difficult in practice. As noted earlier, the lowest contour line in the entrance sink to Pozo del Portillo is 1320 m, but the accuracy of this elevation is unknown. Whereas the surface stream enters the cave at the lowest point in the sink, the entrance for cavers is a few meters above this. GPS readings were not possible from the entrance itself, but were taken back away from it, closer to the campsite. By estimating an adjustment to the elevations obtained near the campsite and by averaging several readings ranging from 1335 to 1317 m, our best estimate for the elevation of the entrance of Pozo del Portillo is 1324 m. Similarly, a variety of elevation readings ranging from 920 to 887 m was obtained for the entrance of Cueva Resumidero del Pozo, with our best estimate being 899 m.

Using 1324 m as the elevation of the entrance to Pozo del Portillo, the Catalan survey endpoint at –384 m, should be at about 940 m elevation. The Catalans explored several hundred meters beyond the last survey point, and are certain their turn around point was at least 400 m below the entrance. They stopped at the top of a drop estimated to be 10 – 15 m. Therefore their deepest penetration should have put them at around 925 m elevation, with at least another 10 m drop in sight, suggesting the lowest known point in Pozo to be about 915 m elevation.

Using 899 m as the elevation of the entrance to Cueva Resumidero del Pozo and adding the surveyed 23 m gain in elevation, we get an elevation of around 922 m at the terminal sump, about 7 m above the supposed low point in Pozo, clearly an impossibility.

From these speculative projections we can conclude the following: 1) one or both entrance elevations are probably off by 10 m or so, as the two projected ending elevations are incompatible; 2) whatever the true elevational differences, the gradient between the end of Pozo del Portillo and Resumidero del Pozo is almost certainly low, and it is likely that much of the cave remaining unexplored is submerged; 3) although some additional cave is known to remain to be explored and surveyed at the bottom of Pozo del Portillo, **the likelihood of adding significant length and depth to the Pozo del Portillo survey by pushing downstream in Pozo seems slight**.

The Catalans report that at a depth of -346 m, the Pozo del Portillo stream is joined by a major side stream, with a volume perhaps three times that of the Pozo stream, coming in from the east (Guarro, pers. com., 2009). Due to lack of time, this stream passage was not explored, but the great volume of water suggests **very good potential for major extensions to the Pozo del Portillo system by exploring up this larger stream.** Nothing is known about the source(s) of the water in this larger stream, however six sinkholes are shown in km square 27/41 immediately south and east of the Pozo del Portillo entrance sink, at elevations somewhat higher than the Pozo entrance sink. Presuming that the nature of the unexplored cave upstream from the junction at –346 m is similar to that of the explored cave, one would expect to run into vertical drops that would present significant challenges to ascend, however, if this branch could be followed back to the surface sink(s) supplying the water, the vertical extent of the cave might be increased. A more practical approach might be to **check the surface sinks in km square 27/41 for entrances and any caves discovered explored to see if they join the Pozo del Portillo System**.

<u>The Speleological Potential of the Montaña de la Flor Structural Belt</u>:

In addition to remaining potential in the Pozo del Portillo System proper, there remains the question of what feeds Cueva del Resumidero of the Catalans? Major sinkholes lying some 2.5 and 4 km to the NW of Pozo del Portillo would be possible insurgences for this resurgence cave, and possibly entries to another deep system relatively close to the Pozo system.

Looking at the bigger picture, Pozo del Portillo, Cueva Resumidero del Pozo, Cueva del Resumidero, Sima Dolina Norte-1 and 28 other caves discovered by the Catalans all are found within a relatively small area around Portillo del Pozo and Montaña Rompeculo. However, this area lies within the Montaña de la Flor Structural Belt (Rogers *et al.*, 2007), a northwest – southeast trending range of deformed (compressed, tilted and uplifted) Mesozoic strata that strikes N50W for approximately 70 km, with a width of 10 to 15 km.

The Montaña de la Flor Structural Belt (MFSB) is truncated by faults in the general vicinity of the *pueblo* of Salamá, and extends northwestward to the city of Yoro, where again it is truncated by faults. While the great majority of the caves known thus far in the MFSB occur in the small Portillo del Pozo – Montaña Rompeculo area, roughly 16 km from the SE end of the MFSB, we believe that the large number of caves in this small area augurs well for similar caves to be found along the strike of the belt, in both directions, but most especially to the NW. Indeed, other caves have already been found. In 1998 Italian cavers explored and mapped Cueva del Portillo de la Peña, a fine through trip with a mapped length of 1615 m and a drop of -84 m (Sivelli and De Grande, 1998). This cave, located approximately 23.5 km NW of the Pozo del Portillo area, is developed in limestone, probably the Cenomanian unit. The 2001 group led by Pete Shifflett found, in addition to the small conglomerate cave already mentioned (16.5 km NW of Pozo del Portillo), Cueva La Mina, a resurgence cave (14.5 km NW of Pozo del Portillo) in limestone, which they started mapping. Unfortunately, a medical emergency forced them to abandon the exploration in going cave after mapping only 195 m. These three caves lie some 14.5 to 23.5 km to the NW of the Pozo del Portillo area, along the general strike of the MFSB.

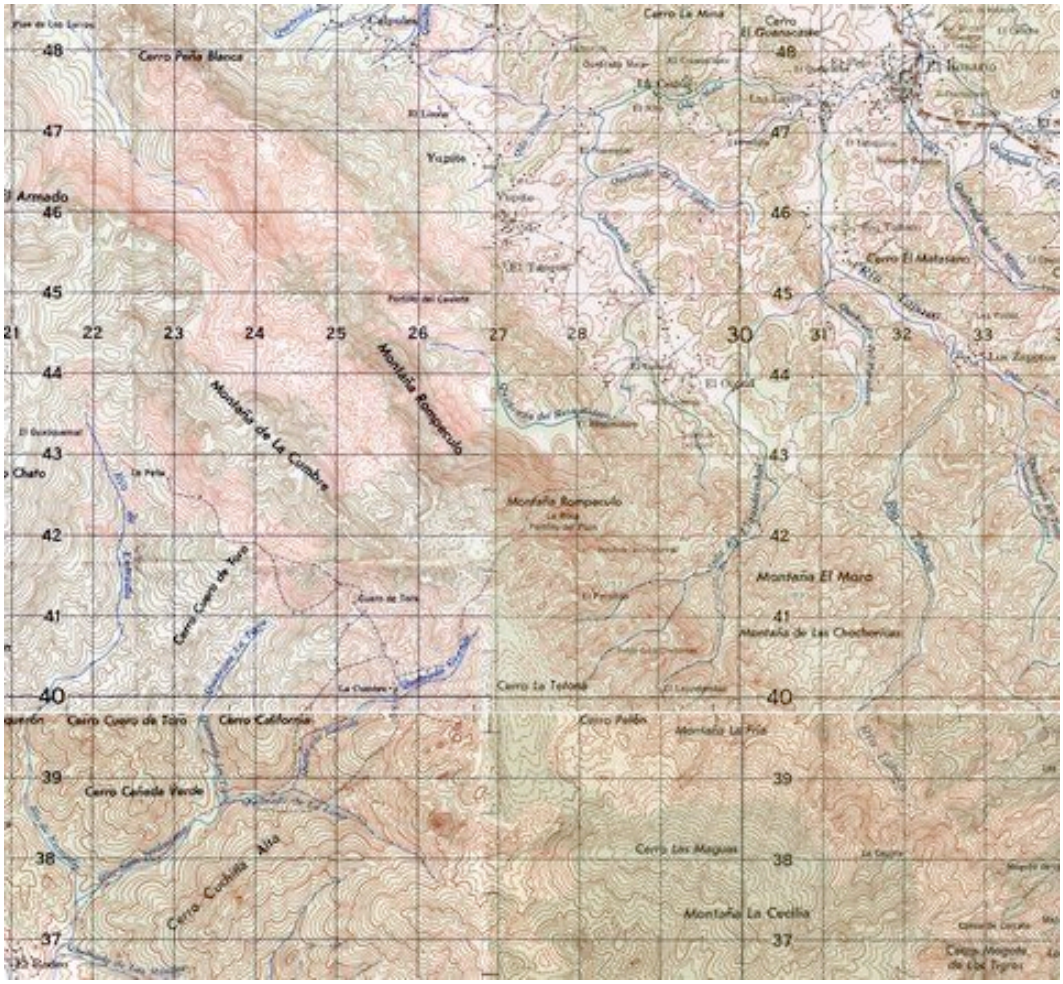
The Montaña de la Flor Structural Belt (MFSB) forms the forested (green) high terrain starting just S of the city of Yoro in the NW portion of the image, and extending SE-ward across the image, narrowing towards its truncation near La Jagua near the SE corner of the image. El Rosario is indicated on the NE side of the MFSB in the east-central portion of the image.

In addition to these additional known caves, karst zones and a few cave entrances are indicated on the 1:50,000 topographic quadrangles crossed by the MFSB. Topographic place names are further evidence of caves: Cueva del Cerrato, Cueva El Tigre, Cueva del Tigre, Montaña de Las Cuevas, Quebrada las Cuevas, Quebrada El Resumidero, Drenaje Subterraneo, and so forth. Appendix I is a listing of the karst names and their localities within the MFSB.

Three karst zones are worthy of being named and described: the Rompeculo karst, the Suroeste karst and the Montaña de Las Cuevas karst.

The **Rompeculo karst** shows on the Montaña de la Flor and Yocón topographic maps as a prominent band of sinkholes extending along strike NW from Pozo del Portillo for some 8.5 km, with a width up to three km. This band of karst includes sinkholes more than a square kilometer in area and over 140 m deep. The karst also continues to the SE from Pozo del Portillo, indicated by sinkholes, for at least two kilometers in the direction of Cueva de Cerrato nearly eight kilometers to the SE on the Salamá quad. Inasmuch as these features are along the general strike line, it is reasonable to guess that they are developed in limestone conglomerate, like Pozo. (However, unidentified offsets by cross faults might easily complicate this supposition.)

Four kilometers due south of Pozo del Portillo is a sinkhole fully a square kilometer in area and over 80 m deep. It is part of a sinkhole complex –the **Suroeste karst**-- with a smaller but deeper sinkhole lying to its NW, and a series of large sinks lying to its SE. Together they form

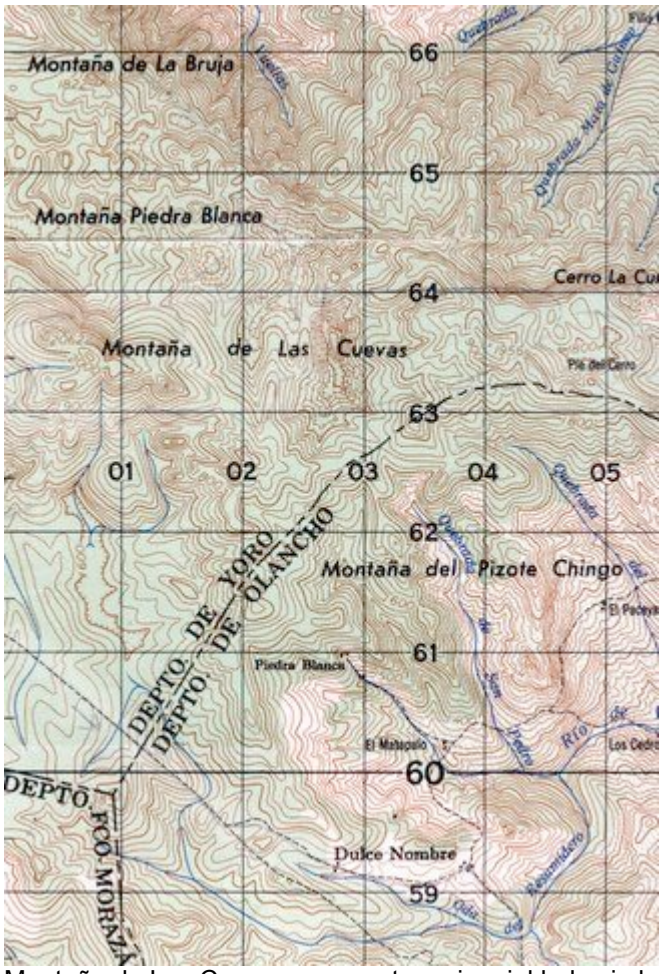


Montaña Rompeculo and Suroeste karst areas, including Pozo del Portillo and other caves.

a linear trend, running approximately 4.5 km NW-SE, apparently representing another karst zone following the strike of a soluble unit. The Orica – Guayape geologic quadrangle map (Gutierrez Sosa, 1996) covers a portion of this area, and shows the karst host here as Atima limestone. If the map is correct, the presence of the thick Atima limestone would be favorable to the development of major cave systems. Local relief is high (500 – 600 m) and the potential for vertical development should be good.

As can be seen on the Google Maps image, the MFSB widens towards the north. Furthermore, the topography rises in this direction, reaching elevations in excess of 2000 m in the Montaña de Yoro – Montaña de Las Cuevas area. Though little, if any, detailed geologic work has been done in this area, it is believed that the thick Atima limestone underlies portions of this region (Rogers *et al*., 2007).

One noteworthy karst zone in the northern portion of the MFSB and shown on the topographic maps is the **Montaña de Las Cuevas karst** on the Mangulile quadrangle. A sinkhole a half kilometer square and at least 120 m deep is shown in km sq 02/63. An even larger sinkhole, over 80 m deep is centered on the next km sq north, 02/64. Other smaller, but still quite large, sinks occur in this same zone. Where the water draining into these sinks resurges is not known, but the place name Quebrada del Resumidero to the south may give a



Montaña de Las Cuevas area; note major sinkholes in km sq 02/63 and 02/64

hint. Local relief in this area is very high, descending more than 1000 m from the high peak of Montaña de Las Cuevas at 2062 m to Rio de Las Coloradas six kilometers away. Access to this area is limited to a few trails and exploration here would require a major effort.

In addition to tilted Atima and other Cretaceous units deformed in the MFSB, Rogers *et al*. (2007) report that ”sub-horizontal, massive limestone caps the folded and tilted Cretaceous strata” in the area of Montaña de Yoro. They further state that “Field investigation of Yoro Mountain reveals that the nearly horizontal-bedded limestone lies above steeply dipping strata correlated with the Valle de Angeles”. Little is known about this limestone unit and its potential for karst development. Should it in places overlie either the Cenomanian limestone or the limestone conglomerates of the Valle Angeles, there should be significant potential for interesting speleological discoveries in these localities.

In summary, we believe that the MFSB has significant potential for additional noteworthy speleological discoveries. Obviously a new world depth record for caves in conglomerate can be set by finishing the exploration and mapping of Pozo del Portillo. There is a good to possibly very good possibility that the depth record for caves in Honduras, currently -420 m, can be exceeded in the MFSB. The two prime target areas are the Rompeculo karst zone and the Montaña de Las

Cuevas karst. The Suroeste karst is a third possible target area, but would be approached from the Rompeculo karst area, by the same trail that passes by Pozo del Portillo.

Recommendations for Future Explorations:

The Montaña de la Flor Structural Belt (MFSB) is clearly worthy of further speleological exploration and we would like to make the following recommendations for future expeditions to this area.

1) We recommend the MFSB as a site for a future speleological expedition of two to four weeks duration, in one or both of the two prime target areas, Rompeculo karst (and, time permitting, its adjunct, the Suroeste karst) or Montaña de Las Cuevas karst.

2) The NSS should be willing to support a properly organized future expedition.

3) Speleological expeditions to Honduras should be in the dry season, i.e., March-April.

4) Official recognition and backing by a Honduran agency, such as the Instituto Hondureño de Antropología e Historia or Instituto Geográfico Nacional or similar central government authority is needed to avoid problems with local authorities.

5) The Unión Espeleológica de Honduras does not at this time (2010) have personnel qualified for serious vertical work; nonetheless, the UEH should be notified of any expedition plan and UEH members invited to participate up to the practical limits of their training.

6) Results of the expedition should be shared with UEH.

7) Access to the Rompeculo karst is via the *municipio* of El Rosario, Olancho, a relatively easy drive of 3-4 hours from the capital city of Tegucigalpa, or a hard five hour drive from San Pedro Sula international airport via Yoro. The Hotel El Costeño en El Rosario is convenient as an in-town headquarters. Local authorities in El Rosario need to be informed of the expedition, and their cooperation obtained, which will be aided by a *constancia* from a central government agency. From El Rosario it is a 30 min drive to the village of El Ocotal, where Sr. Dagoberto Juárez makes his home. Dagoberto aided the Catalans and the 2008 and 2009 American groups and should be asked to aid any future expedition. From El Ocotal, Pozo del Portillo is a two hour hike on a good trail. Access from Pozo del Portillo to other portions of the Rompeculo karst will be considerably more difficult. The Catalans reportedly chopped for three days to open a trail to their “Dolina Norte”.

8) Access to the Montaña de Las Cuevas karst will be quite difficult. The city of Yoro would be the likely first base of operations, from which scouting for a feasible entry would need to be made, a process that might take several days. One possible jumping off point would be the village of Alao. In any case, it is probable that two – three days of hiking and mule portage of camp gear will be necessary to arrive in the Montaña de Las Cuevas karst. But the well-developed sinks here, and the likelihood that this karst zone is developed in the tilted, thick Atima limestone augurs well for good cave potential here.

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Our good friend Dago, with Mary, ready for action! Photo by Pete Miller.

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Appendix I: An inventory of karst suggestive place names on topographic quadrangle maps covering the Montaña de la Flor Structural Belt:

Mangulile quad (2861 III):

Cueva del Tigre (05/69)
Quebrada Cueva del Tigre (04/69)
Montaña de Las Cuevas (01-03 / 63-64)
Quebrada del Resumidero (04/59)

Marale quad (2760 I):

Cueva del Tigre (90/49)
Quebrada Las Cuevas (94/50)

Montaña de la Flor quad (2860 IV):

Cuevas (08/56-57)
Drenaje Subterraneo (08/56) (Cueva El Portillo de la Peña)
Drenaje Subterraneo (14/52) (small conglomerate cave, Shifflett group, 2001)
Qda. El Resumidero (12-13/52-53)

Orica-Guayape quad (2860 III):

Cueva (13/37)

Salamá quad (2860 II):

Cerro Cueva del Zorillo (30/32)
Cueva de Cerrato (32-33/37)

These four additional caves, indicated on the map, are thought to be developed in the Cenomanian limestone, and in all probability lie outside the MFSB.

Cueva (41/31)
Cueva (44/33)
Cueva (46/34)
Cueva de la Mona (49/37)

Yocón quad (2860 I):

El Resumidero (28/43)
Quebrada del Resumidero (27/43)

An additional karst place name, lying well outside the MFSB:

Sabana del Resumidero (47-48/55)

Yoro quad (2761 II):

Cueva (97/66)
Cueva El Tigre (78/65)

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