



### **Search and recovery:**

Jeff Clark arrived at Calimba first, confirmed the missing divers, and called in further divers. Kim Davidsson and Johan Isaksson came with dive gear from Mayan Blue. Other locals arrived as well, including Pål. By this time, it was clear that if the divers had not surfaced in another cenote, this would likely be a body recovery. Robbie Schmittner trekked to nearby cenotes (Pabilanny, Box Chen, Ho Tul and Gran Cenote) to confirm whether they had surfaced in one of these. In the meantime two teams prepared to enter the water to start the search.

The dive plan of Team 1 was unknown, but there had been talk of a dive involving the Lithium Sunset section. Based on this and the fact that the first T-intersection was marked but that no markers or jumps had been found by Team 4 who had dived on the right side of the T-intersection, search Team A was tasked to search left of the T-intersection while search Team B went right. The plan of search Team A was to follow the main line towards Gran Cenote and to search any jumps found and, if no other signs were found, traverse all the way to Gran Cenote and Ho Tul. Search Team B would take a right at the T-intersection and dive the Lithium Sunset section until it connected to the main line coming from the left side of the T-intersection.

Search Team A (Johan and Kim) entered the water at 17:30 with 2 x 80cft sidemount and 1 x 80cft stage each. Search Team B (Jeff and Pål) entered the cave approximately 15 minutes after. The stage tanks of the missing divers were found on the mainline at 15 minutes penetration, clipped to the main line and with 115 and 105 bars respectively in them. At the T-intersection, the cookie of one of the missing divers (Diver 2) was left marking the exit side towards Calimba. The search team took a left turn at the T-intersection and proceeded on the main line. No markers or installed jumps were seen passing the circuit to Much's maze or the jump to Lithium Sunset. Two cookies from Diver 1 were found in the silt on the floor, next to the line, just past the jump towards Lithium Sunset. Further ahead, and a few meters off the line, a handheld light carried by Diver 1 was found on the cave floor.

Upon reaching the jump at Paso de Lagarto, at approximately 50 minutes dive time, Diver 1 was encountered dead. He was found about halfway between the Calimba and the Gran Cenote main lines heading towards the Grand Cenote mainline. There was no jump installed to connect the two main lines. After connecting the jump, search Team A proceeded toward Cenote Ho Tul (following the double arrow marking toward the closest exit) where Diver 2 was found dead on the floor at approximately 55 minutes dive time, just past the end of the line at the gap between the Gran Cenote mainline and the Cuzan Nah section.

Having confirmed the deaths and locations of the missing divers, search Team A exited towards Calimba to inform the waiting authorities and to plan for the body recoveries. Total dive time for search team A was 2 hours.

The body recovery was scheduled for the next morning. Local authorities arranged access from Cenote Ho Tul, and a team of three divers entered the water for documentation and recovery. Recovery was successful and uncomplicated with a total dive time of less than an hour.

### Victims\*:

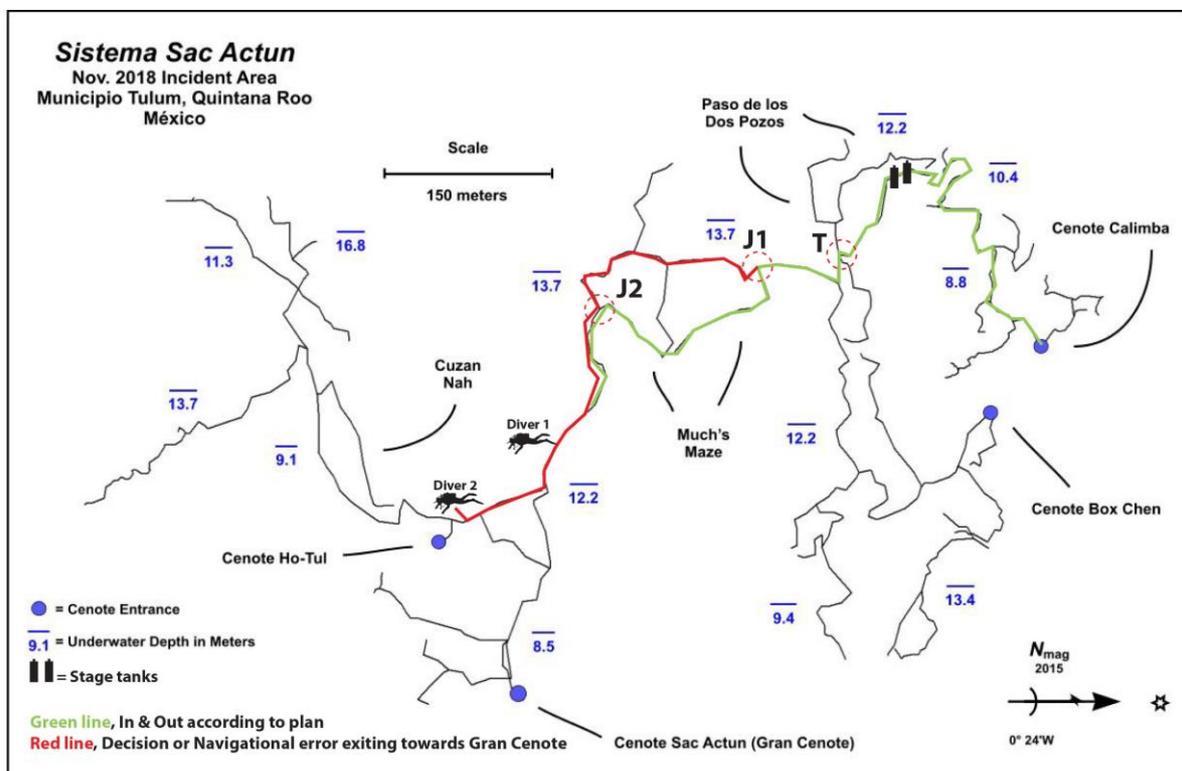
Diver #1 was certified as a full cave diver in 2012. He had visited Mexico several times before and had approximately 150-200 cave dives experience. The diver was using side mounted cylinders configuration (2 x 80cft) with an additional stage tank (1 x 80cft) diving so-called "Toddy-Style" with intermediate length hoses to the second stages.

Diver #2 was certified as a full cave diver in 2015. It was his second time in Mexico, and he had approximately 50-70 cave dives experience. The diver was using side mounted cylinders configuration (2 x 80cft) with an additional stage tank (1 x 80cft) also diving "Toddy-style."

\*Source: Friend of the victims

### Dive route:

The dive was a single stage videography dive entering at Calimba. Filming was done throughout the dive, alternating between the role of cameraman and subject so that each diver had both roles, including some set up shots to film passage through certain features. Stages were dropped at 28 minutes, but due to filming, the penetration distance was equivalent to 15-20 minutes of swimming at a normal pace. The dive proceeded on the Calimba main line to the first T-intersection where markers were placed. The dive then continued past the Box Chen jump into the Paso de Lagarto to a jump (Jump 1), then left into Much's maze, until that line ends with the jump (Jump 2) back to the Paso de Lagarto line. The dive was turned somewhere near the gap from Paso de Lagarto to the Gran Cenote main line.



## Timeline:

Runtime	Location	Based on	Comment
1	Cenote Calimba	Dive log and video	Start of dive
2 - 27.	Filming in Cenote Calimba	Video	
28	Dropping stage tanks	Video and recovery	
29 - 37	Travel to the Calimba T-intersection	Video	
38	Calimba T-intersection	Video	
39-64	Travel to Much's maze, Jump 1 and travel in Much's maze	Assumption	
65	Jump 2 from Much's maze to Paso de Lagarto	Video	
75	Turning dive	Assumption	+/- 3 minutes given available video
80	Taking back jump 2 into Much's maze	Video	
93	Inside Much's maze	Video	No apparent distress
99	Taking back Jump 1	Dive log/survey data	
106	Passing jump site 1 headed towards Gran Cenote	Dive log/survey data	
107 - 126	Travelling towards Hotul - buddy separation at some point	Dive log/survey data	
127	Paso de Lagarto jump / Entrance of Ho Tul	Dive log / recovery	Divers 1 and 2 perish

## Equipment analysis:

Forensic analysis of the equipment revealed no malfunctions or other likely cause of the accident. All regulators and tanks were in working order when tested after the accident. Both divers used equipment suitable for cave diving including line markers and safety equipment such as wetnotes, line cutters, backup lights etc. In the recovered wetnotes text in German was found saying:

-“Egal wo! Raus!”

-“Grand Cenote? Ok”

Which translates to “No matter where! Out!” and the obvious mention of destination. In the other divers wetnotes there was a further discussion about stage tanks with the text in German roughly translating to “What about the stages?” but it is unknown if that pertains to this dive or a previous one.

## Discussion:

*This part of the report contains speculation and represent our best guess at what happened.*

In the initial report, we speculated on navigational error or gas management errors as the probable reasons for the fatality. The presence of the discussion in the wetnotes as well as the dive log confirmations of total dive time eliminates navigational error. It was a conscious choice to head for the Gran Cenote exit. The time gap between the last recorded video and the divers perishing does not leave time for any significant navigational error to occur. Post-accident analysis of the equipment revealed no sign of malfunction, which makes a loss of gas due to free-flow or faulty tanks unlikely. The most likely remaining cause is a diver error with regards to gas management.

Given that video recordings were still done with no signs of distress at 93 minutes and that both divers perish at 127 minutes, with all four sidemount tanks empty, we have made the following assumptions with regards to gas consumption and awareness:

1: We assume that the penetration on the sidemount tanks was planned to thirds.

2: We think that one diver knowingly or not passed thirds at turn and/or return.

3: That diver notified his buddy just after the jump out of Much's maze, causing the wetnotes discussion and the choice to head towards Gran Cenote

4: Distress caused a rapid increase in breathing and gas usage beyond the decision to change exits.

5: That a gas share situation occurred at some point during the exit

We think that diver 2 notified diver 1 of critical gas reserves around minute 103 and that they, after discussing, decided to head for the exit at Gran Cenote/Ho Tul. This decision was likely influenced by the characteristics of the cave passage, with the downstream tunnels being larger and with no restrictions. It is also possible that the downstream flow was a contributor to this choice.

Rapidly increasing gas use caused Diver 1 to share gas from one side-mount tank once Diver 2 had almost depleted his. When gas from the shared tank ran out the team separated, with Diver 2 using what remained in his tanks to reach Cenote Ho Tul (but not surfacing) and Diver 1 breathing down what remained in his sole tank, perishing at the jump from Paso de Lagarto.

Comments on Assumptions:

1. Deviation from the rule of thirds in gas planning is very rare in the cave diving community.
2. One diver either pushing his turn pressure or grossly underestimating his gas use for the return is the most likely explanation for what must have been a critical gas issue at 100 minutes of penetration, a mere 25 minutes after the turn and a total out of gas situation approximately 50 minutes after the turn. If the dive was done to thirds, about 140 bar in each tank would remain when turning at minute 75, having dived 45 minutes after the stage drop to reach this level. At that rate the sidemount tanks would have around 100 bar remaining when leaving Much's maze. This is perhaps on the low side but far from critical for the 25 minutes of swimming remaining to reach the stage tanks.
3. This is likely because video logs show no apparent distress at 93 minutes runtime and the dive computer profile logs show two passes of the same shallower section within a few minutes of each other shortly thereafter, around minute 105.
4. This is a reasonable conjecture given diver psychology as well as the gas usage assumed for the last twenty minutes of the dive.
5. Diver 1 had one regulator deployed for gas sharing while found a further distance from the exit than Diver 2, and both divers perished at the same time. This could either result from a remarkably similar gas consumption or a gas-sharing scenario to even out the likely differences in SAC.

### **Conclusion:**

The fatality was caused by diver error, more to the point, failure to obey proper gas planning. The key contributing factors were:

**A failure to observe the rule of thirds, either knowingly or unknowingly**

**Using the rule of thirds in a setting that it was not designed for**

**Non-conservative use of stages in dive-planning and execution**

The rule of thirds was originally designed for three-diver teams, entering against the flow and exiting with the flow. In this case, divers entered with the flow in a two-man team and very likely also pushed the turn either willingly or by lack of awareness. The stages were dived according to the rule of halves, which is usually associated with using the rule of fourths for the primary tanks, but it is unlikely that this was done. Furthermore, the tanks were dropped based solely on when turn pressure was reached. Because of delays associated with filming, this meant that they were left 15 minutes of penetration from the entrance, rather than 20-30 minutes in. It is often advisable to carry stages a bit farther after switching to backgas/sidemount tanks for an extra margin of safety on the return. If the tanks had been carried farther into the system to around 30 minutes of penetration distance from the Calimba entrance, the distance to the stages at the point of realizing the critical levels of gas remaining would have been 10-15 minutes of swimming at a moderate pace. Videography may have been a contributing factor to the lack of awareness due to increased task loading.

#### **Our recommendations to the dive community:**

Do not consider the rule of thirds as an end-all conservative approach to cave diving. It is only a conservative route to gas planning given certain circumstances. If these circumstances do not apply on a particular dive, choose a more conservative strategy.

Consider various aspects of gas planning when stage diving. Gas that you do not have and cannot reach does not help you. If in doubt, seek advice or training on suitable strategies.

Dive conservatively and be mindful. When you dive too close to and/or push the limits, the risk drastically increases and your time to solve any potential problem decreases, "everything will feel perfectly fine, until it doesn't..."

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Respectfully Johan Isaksson and Kim Davidsson