University of Leeds Speleological Association: Report on the Pilotera Canyoning Incident, 10th June 2017

Introduction

Background

During June 2017 a number of LUUCAS (Leeds University Union Caving Adventure Society) cavers were on a canyoning trip in Italy as part of the LUUCAS summer holiday. On the 10th June 2017 a group went on a canyoning trip down Pilotera canyon in the Lake Como area of Italy. An incident occurred, resulting in serious injury to a trip member. This incident report has been written with the aims and objectives as outlined below.

Aims and objectives

1. To establish the facts surrounding the incident,
2. To identify factors that contributed to the incident,
3. To establish what reasonable measures could be put in place to prevent similar incidents from occurring, and;
4. To enable these measures to be discussed and implemented within the club.

Ground Rules

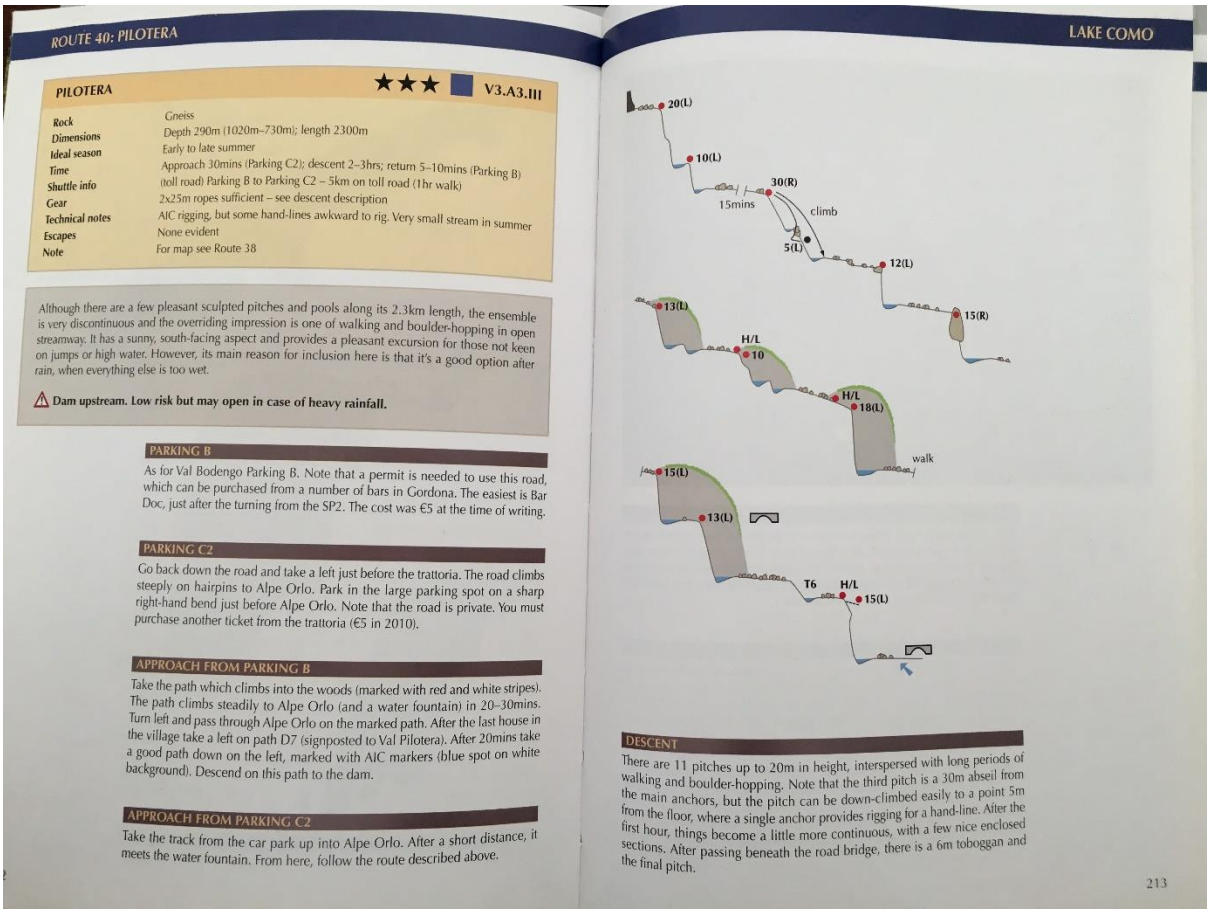
1. The analysis will focus on identifying processes and will avoid blaming individuals,
2. It is acknowledged that individuals involved may be distressed by the incident and efforts be made to support them through this process,
3. The editor reserves the right to seek clarification about the meaning of submissions and edit them accordingly,
4. A summary of the report may be published by the club and made public as an educational resource for the wider community, and;
5. Information made public will be edited to protect the identity of individuals involved.

Trip Members

1. Trip Member 1 – TM1
2. Trip Member 2 – TM2
3. Trip Member 3 – TM3
4. Trip Member 4 – TM4
5. Trip Member 5 – TM5
6. Trip Member 6 – TM6
7. Trip member 7 – TM7

Description of the Canyon

Guidebook Description



ROUTE 40: PILOTERA

LAKE COMO

PILOTERA ★★★ V3.A3.III

Rock	Gneiss
Dimensions	Depth 290m (1020m–730m); length 2300m
Ideal season	Early to late summer
Time	Approach 30mins (Parking C2); descent 2–3hrs; return 5–10mins (Parking B)
Shuttle info	(toll road) Parking B to Parking C2 – 5km on toll road (1hr walk)
Gear	2x25m ropes sufficient – see descent description
Technical notes	AIC rigging, but some hand-lines awkward to rig. Very small stream in summer
Escapes	None evident
Note	For map see Route 38

Although there are a few pleasant sculpted pitches and pools along its 2.3km length, the ensemble is very discontinuous and the overriding impression is one of walking and boulder-hopping in open streamway. It has a sunny, south-facing aspect and provides a pleasant excursion for those not keen on jumps or high water. However, its main reason for inclusion here is that it's a good option after rain, when everything else is too wet.

⚠ **Dam upstream. Low risk but may open in case of heavy rainfall.**

PARKING B

As for Val Bodengo Parking B. Note that a permit is needed to use this road, which can be purchased from a number of bars in Gordona. The easiest is Bar Doc, just after the turning from the SP2. The cost was €5 at the time of writing.

PARKING C2

Go back down the road and take a left just before the trattoria. The road climbs steeply on hairpins to Alpe Orlo. Park in the large parking spot on a sharp right-hand bend just before Alpe Orlo. Note that the road is private. You must purchase another ticket from the trattoria (€5 in 2010).

APPROACH FROM PARKING B

Take the path which climbs into the woods (marked with red and white stripes). The path climbs steadily to Alpe Orlo (and a water fountain) in 20–30mins. Turn left and pass through Alpe Orlo on the marked path. After the last house in the village take a left on path D7 (signposted to Val Pilotera). After 20mins take a good path down on the left, marked with AIC markers (blue spot on white background). Descend on this path to the dam.

APPROACH FROM PARKING C2

Take the track from the car park up into Alpe Orlo. After a short distance, it meets the water fountain. From here, follow the route described above.

20(L) 10(L) 30(R) 15mins climb 5(L) 12(L) 15(R) 13(L) H/L 10 H/L 18(L) walk 15(L) 13(L) T6 H/L 15(L)

DESCENT

There are 11 pitches up to 20m in height, interspersed with long periods of walking and boulder-hopping. Note that the third pitch is a 30m abseil from the main anchors, but the pitch can be down-climbed easily to a point 5m from the floor, where a single anchor provides rigging for a hand-line. After the first hour, things become a little more continuous, with a few nice enclosed sections. After passing beneath the road bridge, there is a 6m toboggan and the final pitch.

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Guidebook Grading Explanation

V3.A3.III

Vertical Character 3 - Simple abseils up to 30m in a weak current into calm water; simple hand-lines; some slippery, unstable or exposed passages; some tricky down-climbs (up to French 3c).

Aquatic Character 3 – Swims no longer than 30m in calm water; progression in a weak current; simple jumps of 3-5m; longer toboggans or moderate slopes.

Engagement III – Time to safe ground 30mins, Time to escape 1hr, Total time (approach, descent and return) – 4-8hrs.

Brief Factual Trip Summary (see Appendix A for full reports of the trip from each trip member)

Trip

A group of five LUUCAS members left their campsite at around 11:00 along with two further LUUCAS members (TM 6 and TM7) who would spend the day climbing in the area. The canyoning party left their vehicle at around midday and entered the canyon Pilotera at around 13:00.

TM2 had completed the trip earlier in the week. Water levels were low, the forecast was settled and conditions were good. TM1 and TM 2 rigged the majority of the pitches and the group made good progress through the canyon, arriving at the final pitch at around 17:00. The final pitch consisted of a traverse line and 15m pitch.

Incident

TM6 was waiting for the canyoning group at the bottom of the final pitch having finished climbing for the day. They had walked up the accessible lower part of the canyon to meet the group as they completed the trip.

TM1 rigged the final pitch. They had already rigged a traverse line and was then passed a 30m rope by TM2 for the abseil. The pitch was rigged with a pull-through traverse line and biner-block pull through as had been used in previous pitches. TM6 assisted at this stage by providing visual confirmation from the foot of the pitch that the rigged rope was of adequate length. TM1 appeared to attach their figure-of-8 descender to the rope but on beginning to descend they fell freely. The rope also fell down the pitch. TM1 impacted with two rock ledges during the fall and was initially unconscious, face down in the water at the foot of the pitch.

Response

TM6 was the first to provide assistance whilst help came from the rest of the party, who were yet to descend the pitch. TM6 entered the water and began to move TM1 across to the side of the pool, keeping TM1's head out of the water. The water was deep and alone, TM6 could not move TM1 out of the water. TM3 hard-rigged the 15m final pitch and descended into the pool. TM3 and TM6 then moved TM1 across to sloping rocks, where they could remove them from the water. At around this time, TM1 regained consciousness but was confused and combative. It was noted that they were moving their arms and upper body but not their legs. TM3 and TM6 attempted to keep TM1 as still as possible whilst TM4 and TM5 descended the final pitch on TM3's rigging. TM2 then re-rigged the pitch to descend and pull through. TM2 noted the time just prior to their descent as 17:24.

TM3 noted that at the foot of the pitch, TM1's figure-of-8 descender was attached to the rope. No biner-block was noted on the rope, although a full inspection of the rope was not carried out due to the urgent nature of the situation. This was not possible after the initial response to the incident, as the rope was packed away by another canyoning group, who helped in the incident response. TM3 removed TM1's descender from the rope to free them and allow them to be removed from the water.

TM6 left the scene to seek help and met TM7 on the walk out of the canyon. They returned to the vehicle together to use a phone to contact emergency services. TM4 and TM5 also left the scene soon after as TM5 was able to drive the vehicle to assist in securing help. On walking back to the scene, TM6 met another canyoning group on their way out of another nearby canyon, Bodenga II. They were an Italian group consisting of a number of canyon rescue members. They also called for help and attended the scene. Assistance was provided by a nurse on the rescue team.

TM2 and TM3 remained with TM1, who continued to be agitated and appeared to be complaining of back pain but was unable to answer questions or speak coherently. TM2 and TM3 kept TM1 as still and warm as possible until further help arrived.

TM1 was moved by helicopter to Gravedona Hospital, around 45 min away. After TM1 was moved, TM2 and TM3 re-joined the rest of the group at the vehicle. The time was noted as 20:34. TM2, TM3 and TM7 continued on to Gravedona Hospital where they identified TM1 and provided ID and insurance details. This group contacted TM1's parents who flew out the following morning. The insurance company and Leeds University Student Union were that evening also informed of the events.

Incident Analysis

Analysis of Incident - Cause

Analysis of the information provided suggests that there are three potential causes for TM1's fall. With the information available, it is not possible to determine with 100% confidence which one of these was the cause. However, the learning points are consistent and may help to avoid similar incidents in future.

1. TM1 placed their descender onto and descended on the dead side or the rope (wrong side of the carabiner block) causing TM1 to fall along with rope, or:
2. Carabiner block rigged incorrectly, causing rope to slip through belay and TM1 to fall along with rope to the pitch base.
3. Rope / hardware failure causing rigging approach to fail – the trip reports make no reference to any description that would point to this as a cause for TM1's fall.

Other potential causes are less likely given the information provided, including:

1. Descender not being attached to TM1 – TM3 report confirms that descender was attached to TM1 at the bottom of the pitch.
2. TM1 descender not being configured on rope appropriately – TM3 report states that rope was found on descender and looked to be set to Figure of 8 extra friction position.
3. Block not large enough to block against anchor when weighted – discounted due to carabiner-block approach (is a possibility under knot-block approach).

Commentary on Preventative Measures

Given our understanding of the likely cause of the fall, there are a number of preventative measures that are commonly applied to safeguard against similar incidents. These are summarised below.

Measure Description	**Applied Commonly in Club Trips?**	**Covered in existing LUUCAS Training?**	**Applied by TM1?**
1. Testing descender / rigging setup Following standard cowstail protocol for testing descender rig suitability.	Yes	Yes	TM4 and TM5 reports confirm that TM1 was using cowstails on the trip and on the pitch prior to the incident. However, TM5 describes TM1 releasing cowstails in non-standard manner (long first and then short). There is no mention of TM1 'testing' descending configuration prior to this. It is possible that this was impractical in common form due to the stance at the pitch head. However, it is

Measure Description	Applied Commonly in Club Trips?	Covered in existing LUUCAS Training?	Applied by TM1?
			considered likely that if this has been followed then the incident may have been averted under either cause.
2. Safety hard rigging Whether using knot or carabiner blocks, a safety knot can be applied behind the block (on the unblocked side of the rope) using a screwgate to 'hard-rig' the rope to the anchor. This means that both sides of the rope may be safely descended by all bar the last trip member.	Not at present.	Not at present.	No. If this measure had been applied, then the incident would certainly have been averted under either cause.
3. Good rope management	Yes.	Yes.	Unclear. Though the report author believes that the unblocked rope had been kept at the pitch-head in a tackle sack for the majority of the trip, it is believed that under the multiple rigs for the final pitch of this trip the unblocked rope may have been hanging down the pitch. If this measure had been applied, then the incident may have been averted if the cause was rigging on the wrong (unblocked) end of the rope.

Contributing Factors

It is clear from the information provided in the trip reports that TM1 was calm and considered throughout the

trip, as evidenced by TM3 description of TM1 declining to jump the previous pitch and the overall descriptions from all trip members. The reports provided do not suggest there was undue pressure of time on TM1 when rigging, either due to available daylight, injury or condition of other trip members, or fixed trip deadlines. However, it is noted that there often can be a 'pressure to perform' whilst rigging pitches safely, both in canyons and caves alike. This is often greatest when many trip members are observing the rig or passing an obstacle, as in this incident. It is not suggested that this caused TM1 to rush or distracted them from required attention on the rig and passing of the final pitch, but it is noted that it could conceivably be a contributing factor in similar incidents.

Commentary on Response and Callout

The reports show that all trip members responded in a safe, responsible manner and in a very positive fashion to the incident. They were able to support and care for TM1 whilst the rescue arrived and after, including making the appropriate arrangements with TM1's family, the club and the union. The reports describe the trip members providing much needed support to one another and TM1 and this should be recognised.

Observations in terms of the response and call out are summarised below:

- Key team members who were first to respond had valid outdoor first aid training certificates. Because of this they were able to respond appropriately to TM1's needs until help arrived, and it is considered likely that this stopped TM1 enduring further injury.
- Call out was undertaken based on local protocol. However, it was fortuitous that the second canyoning group arrived with local rescuers and satellite phone. This enabled quicker emergency response from the rescue nurse, and quicker helicopter and rescue party arrival. Under different circumstances (e.g. if TM1 had sustained an injury resulting in significant blood loss) this difference in response time may have been critical for TM1's outcome.

Suggested Learning Points and Action Implementation

Preventative Measures

1. Develop targeted training sessions for non-caving rigging and rope handling/passing techniques that may be used on club trips. This should include education on available techniques for rigging and passing these safely. Protocol should consider:
    - **Rigging:**
        - Pros/cons of different approaches under scenarios – including consideration of carabiner and rope blocks, canyon specific hardware (e.g. figure of 8) and flexibility this provides for double rope descent and pull through,
        - Application of safety line hard rigs (knot or canyoning quickdraw based) in descending (all bar last party member), and;
        - Good rope management – benefits of good rope management and keeping unblocked rope in bag until last trip member descends.
    - **Passing / descending:**
        - Reinforce importance of protocol for cowstail use and test descent setup and alternatives for this if pitch head stance makes this impractical.
2. Continue to foster a club culture where those rigging and passing pitches and rigged obstacles can feel confident in taking the necessary time to be absolutely certain of the approach they are taking, ensuring their safety and that of their peers. This could in part be achieved by teaching club members about the dangers of stress, the causes of stress, identifying symptoms and managing it before it escalates. Examples of how this has been taught in the fields of diving and cave diving can be seen in Appendix B.

Response Measures

1. Ensure that all members of a trip know the procedure to follow in case of an accident, including that the emergency services number for mountain rescue services in continental Europe is **112**. Ideally, the following should be considered:
    - Where the call out telephone is stored and the access code for it if relevant.
    - Where the nearest signal is, or nearest landline.
    - Local language translation for key call out text – this does not have to be location specific for each canyon, but should highlight as a minimum that a member of a canyoning trip has had an accident and is in need of immediate assistance.
2. Continue to support opportunities for club members to take part in outdoor first aid courses, ensuring the best possible immediate care can be provided to trip members when accidents occur.
3. Investigate the possibility of carrying a club mobile phone, satellite phone and / or personal locator beacons or similar with the group on trips in order to facilitate quick call out.

Next Steps

At this stage, the following next steps are proposed:

1. Circulate to trip members and ULSA president.
2. Confirm members happy to issue as final.
3. Club president to issue as final to committee and members.

Bibliography

1. Canyoning in the Alps, Northern Italy and Ticino, *Simon Flower*

Appendix A – Trip Member Reports

Incident Comments TM1 – Saturday the 10th of June

- TM1 has limited recollection from their fall to waking up from sedation 2 days later.
- TM1 remembers whilst rigging being anxious about the block and how it sat against the bolt.
- TM1 also remembers testing their descender setup on both cowstails as there was sufficient slack based on their rigging stance.

Incident Report TM2 – Saturday the 10th of June

The MPV set off from camp at around 11:00 o'clock. A group of 5 people went canyoning consisting of Me, Trip Member 3 (TM3), Trip Member 1 (TM1), Trip Member 4 (TM4) and Trip Member 5 (TM4). Well a lift was given to Trip Member 7 (TM7) and Trip Member 6 (TM6) so they could do some climbing in the area. We set off from the car park at 12:00 and I, having already done the canyon 2 days previously, was able to lead the group to the start of the canyon.

We got changed and I would estimate that the canyon was started at about 13:00. TM1 rigged the first pitch well, I derigged. With prior knowledge of the canyon from two days previously quick progress was made as I knew what to expect and where it was suitable to jump. Me and TM1 alternated in rigging the pitches and pulling through and we we're soon at the final to last pitch which I rigged; everyone else descended before I derigged and pulled through packing the rope back into the tackle sack.

TM1 had gone on ahead to rig the last pitch which consisted of a traverse line and a 15m pitch. By the time I had finished de-rigging and packing the rope TM1 had rigged the traverse line and required a rope to descend the pitch. I gave him the 30m we were carrying. I checked my camera for the time, having lost my watch when I got changed, noting it was 17:04 and what good time we had made.

TM6, having walked in from the Car Park having finished climbing early, was waiting at the bottom of the last pitch. They provided assistance in determining the precise length of the rope required for the pitch. I then saw TM1 appear to attempt to descend but proceeded to go into freefall, with their front to the pitch face, they were falling backwards; the rope proceed to follow them down the pitch before landing in the pool at the bottom. Having later viewed the pitch I presume he must have bounced on the edge of the pitch as it was at a slant before landing in the water.

TM6 was alerted to the situation by TM3 and dived into the pool to provide support TM1 was currently unconscious and not responding. Since the rope had gone down with TM1, TM3 hard rigged the pitch with a another rope we had been carrying and descended down to provide support to TM6 in extracting TM1 from the water. TM1 became conscious and started moving his hands. Having extracted TM1 from the water TM1 was placed on a ledge at the water edge. TM6 left the canyon to call for/find help. I re-rigged the pitch and TM4 descended followed by TM5. At this point I took a photo which comes with a time stamp of 17:24, at which point I descended leaving the rope ready to be pulled down.

Having assessed that it was impossible to move TM1 to a more convenient position, buoyancy aids were used to provide extra comfort. Determining that TM5 and TM4 could no longer provide assistance, TM4 was sent off to update TM6 on the situation with TM5 following in case the MPV needed to be driven to find signal. TM4 soon returned having found some other canyon guides who had been leading trips down Bodengo 2. As it happened some of them were part of the the local canyon rescue and they proceeded to call for help; I am unsure if this bypassed certain bureaucracies and resulted in quicker callout. TM4 continued out of the canyon.

TM1 was very active moving his arms a lot and trying to get out of wetsuit. Although conscious TM1 would not maintain a conversation and did not respond to simple questions. Me and TM3 tried to restrict movement, however this appeared to cause more pain than when TM1 was moving. TM1 managed to position himself using his arms into a position that I presume felt more comfortable. Me and TM3 focused on maintaining TM1's consciousness and trying to restrict their movement as gently as possible.

The canyon rescue nurse appeared and proceeded to check vitals. Me and TM3 continued to provide TM1 support in maintaining their position restricting movement and ensuring they did not go unconscious. The nurse administered morphine which TM1 did not like and tried to remove from their arm using their teeth; they continued to request that the bandage/needle be removed so some restraint was required to prevent this. They also complained about their shoulder which appeared to have popped out and was requesting that we help them put it back in. With the imminent arrival of the helicopter me and TM3 were told to leave and the rescue team proceeded to move TM1 into a stretcher ready to be winched into the helicopter. Me and TM3 arrived out of the canyon at about 20:34, about 3 hours after the incident.

TM7, TM6, TM4 and another from camp were all waiting at the carpark. We waited in the carpark and eventually heard the helicopter come in and leave. We had to wait until the rescue team came to the carpark so that we could find out where TM1 was being flown to. Having found out what hospital they were going to we went back to the campsite to regroup. It was decided that TM3, me and TM7 would go to the hospital. The hospital was in Gravedona about 45 mins away from the campsite. We arrived and formally identified TM1 giving the hospital their passport. The doctor then informed us that they had a cranial trauma and a lesion of their spine.

TM3 phoned TM1's next of kin and the doctor also explained over the phone the seriousness of the injury. TM1's parents informed us of their intention to fly out. I phoned the insurance company. I phoned the university's 24hr security to inform the union of the situation. TM1 was moved to intensive care so we moved from the A&E waiting room. TM3 tried to get some sleep. The doctors were informed that TM1's parents would be arriving the next morning. TM3 went to collect TM1's parents from Milan Mapenza Airport. TM1 was seen briefly on the way to get scanned and recognised us. TM3 returned with TM1's parents and they were allowed to see them. We then proceeded to handover and the insurance company was informed of the situation and the contact details of TM1's parents.

Incident Report TM3

We were Canyoning down Politera on Saturday 10th June 2017. Water levels were low and remained low, conditions were good. TM2 having done Politera earlier in the week was able to guide us down the canyon. Hence, we were very much within our comfort zone.

TM1 and TM2 had been rigging and de-rigging most of the pitches. As I had injured my ankle earlier in the week I decided to take a back seat with the rigging, trusting TM1 and TM2 to have it covered. They each having as much canyoning experience as myself, and both seemed confident with techniques I was unfamiliar with. Such as:

Using a Biner-block for pull through anchors. I usually use a caving style pull through, fig8 knot clipped back into the abseil line.

Abseiling with a fig8 descender. I've generally used a petzl stop, but was trying out a fig8 today.

Rigging pull-through traverse lines.

The above made me feel confident in both their abilities.

I jumped the penultimate pitch, as TM6 had on the previous trip here. I expected TM1 to follow, as I know they, like me, enjoyed jumps. It was a slightly technical jump, involving climbing out left from the pitch head, around and above any potential protection in order to avoid the stepped nature of the rock at the pitch head / waterfall, and also required jumping out a fair distance to avoid the convexed left-hand side rock wall. Therefore I wasn't surprised TM1 decided to be cautious, not jumping but abseiling down the pitch. An act I think shows a sensible and careful state of mind.

All was going smoothly and there was a fun and jovial atmosphere to the group.

At the final pitch head we saw a sunburnt TM6 sat waiting below the pitch for us. Me and TM2 were hanging back from the pitch head, sorting out the excess bags and gear. I fleetingly considered throwing my bag of rope down to TM6 for him to carry, but decided that we might as well keep it at the top in case we need to attach it the pull-down side of the final pitch rope, as I wasn't 100% sure that rope was long enough. The time is just past 5o'clock.

Meanwhile, TM1 was rigging the final pitch. Rigging a pull through traverse line as the ledge above the pitch was slippery, followed by what I believed to be a biner-block pull through.

I remember TM6 guiding TM1 to get the perfect abseil length*, this involved TM1 rigging the pitch, TM6 shouting from below if it needed to adjusting (more/ less rope), and then TM1 re-rigging the pitch accordingly. I was not paying close attention to this activity, so can't be 100%, but from memory two or three adjustment re-rigs happened before they were both happy it was the perfect length.

** So as to avoid being tangle in the abseil line in deep water below a pitch, it's common practice to rig abseil lines to stop just short of the water surface. More important in turbulent water than calm water, as was the condition at the time.*

I turned my back.

I heard TM6 shout and turned back to look.

In my head I see an image of TM1 being mid-cartwheel mid-fall down the pitch. I can't guarantee I saw that image, or that my mind put it there as part of processing what was going on.

I run to the pitch head to look.

TM1's body is floating unconscious in the pool below.

The rope he had rigged had fallen with them.

TM6 was stood screaming at TM1 "No TM1!"

I shout down to TM6 that they need to get their body out of the water quick.

TM6 responds by jumping in.

I search for spare rope in the bags at the pitch head. No rope.

I run back to the excess rope bag I previously held.

TM6's screaming repeatedly from below:

"Get down here quick!"

"Stay with us TM1"

From the bag I grab the other rope.

Fumbling I try to rig a rethreaded fig8 directly into the bolt.

Aborting that, I believe, I rig a double fig 8 and clip it into the bolt.

TM6's still shouting below.

From the desperation in their voice I think TM1 is dead.

I pause for a panicked millisecond. Trying to decide how best to abseil down.

The petzl stop currently on my side, most reliable by most faff.

The fig 8 on my d-ring rigged with minimum friction. Least faff but most risk.

TM6 screams from below "GET DOWN HERE!"

The fig 8 with more friction.

TM2 speaks calmly from my left. "Take your time, make sure you rig it right."

I compose myself, realising I shouldn't add myself as a casualty, I choose option 3.

I abseil as fast as I could, dive into the pool to assist TM6.

TM6 has towed TM1 to the steep sided boulders where TM6 was previously sat, but they're still in deep water and can't get out.

I identify a sloping ledge close to water level to the true left of the pool, with TM6's assistance I tow TM1 across, stabilising their head as I was taught during Sport Diver training.

TM6's shouting at TM1 to fight.

At this point I notice TM1 has regained consciousness. They start swimming with their arms but as they do their face goes back underwater.

We get them to the ledge.

TM1's fig-8 descender is attached to the rope in, I believe, the extra friction position. I don't know how much rope is either side of the descender but there seems to be a significant amount either side. The rope is tangling, so I unclip their descender from their D-ring. There did not appear to be a biner-block on the rope although I didn't get the chance to thoroughly check.

We drag them into a slightly back sloping crack so they don't roll back into the pool.

I tell TM6 to run and get rescue, it's serious and we'll need a helicopter hear ASAP.

TM5 and then TM4 abseil down. TM2 re-rigs the rope at the top of the pitch, from a hard-rigged fig 8 knot, to a pull down rig. Removing the traverse line before abseiling down.

Meanwhile I've been checking TM1 over for injuries. There is froff in the mouth but their airways are clear. They're partially responsive to my questions, such as opening their mouth for me to check, but struggles to talk and seems confused. There's some clear sticky 'fluid' from their nose which I believe is snot, and possible a bit of blood in with it. No fluids are coming from their ears. Their feet are at a slight funny angle, so may have broken ankles. There's a lump at the top of his thigh, which I believe to be a broken femur at first (later during the course of the rescue I realise they've got a pocket there and the lump is some form of mushroom inside the pocket). They keep reaching down to their right hip/ right abdomen, so I suspect they may have broken their pelvis. They're screaming of pain from their back, so I suspect they have a spinal injury.

Their helmet is completely intact with only minor scratches on the left side, it's still on them with the chin strap looking uncomfortably tight against their throat, possibly suggesting their helmet moved out of position.

I remove the helmet to make them more comfortable and to allow me to inspect their head, stabilising their

neck as best I can. There doesn't appear to be any external signs of damage, e.g. no bleeding from the scalp so I hope there to be no head injuries, however their slurred speech, the fact they were unconscious, and their overall confused state indicate that they have sustained a head injury.

By this time TM2 has joined us. TM1 seems to be extremely uncomfortable in the position they're in, in the slight crack, and keeps trying to move. I beg with them not to move, saying they're best moving as little as possible, and that it won't be long until rescue is here and then we'll be able to move them safely on a stretcher. They continue pleading to be moved in mumbled voices. After looking at the potential other places, we eventually agree to spin them around 90□, so they're perpendicular rather than parallel with the pool and crack, their back supported flat against the slope of the ledge. Our buoyancy devices are laid flat across the crack making it flatter, and an empty tackle sack is placed under their head to support their neck.

Once moved, TM4 and TM5 head off to give the rescue team an update of TM1's condition. Me and TM2 stay either side of TM1, waiting for the rescue to come while trying to reassure TM1. They're wanting to strip off their wetsuit, but as we're concerned there may be bleeding and that the wetsuit may be helping act as a compression, while also keeping them warm, we insist they keep their wetsuit on.

Soon another canyoning team arrive, who had been canyoning down the adjoining canyon, Bodengo 2. One of this group spoke good English and acted as a translator for the rescue team. Another two happened to be members of the local rescue team and were able to direct the rescue team to our location. They insisted we kept TM1 awake. Not long later a full rescue team had abseiled down the left slope to us, rigging a traverse line as they went. With them came a rescue nurse, who performed an assessment of TM1 before getting us to strip off their wetsuit to, so he could administer what I assumed to be a morphine drip.

By this point TM1 had become very wriggly and seemed very confused by what was going on. They kept trying to sit up and kept trying to bite off the morphine drip in their left arm.

TM2 and I were doing all we could to keep TM1 still, by pleading with them and by holding down their arms so they couldn't pull themselves up. I told them they had to trust the rescuers, but they didn't seem to understand.

As the helicopter was on its way, the other canyoning team started packing up our gear, so that it wouldn't get tangled up in the wind. Hence, I never got a chance to inspect the rope for a biner-block.

In order to get TM1 into a stretcher the rescue team wanted me and TM2 out the way, so sent us off back to the car park.

From the car park I walked to the bridge which overlooked the canyon, there I saw TM1 on a stretcher being winched up into the helicopter.

It felt like 30 to 40 mins since the fall, but the time was coming up to 8pm and nearly 3hrs had passed.

After a short wait we were informed he'd been taken to Gravedona Hospital.

We drove the MPV back to the camp. Collected TM1's essential items (phone, wallet, passport, etc) and some sleeping bags for ourselves then me, TM2 and TM7 drove the hire car to the hospital, about 1hr away.

When we arrived we were informed TM1 had sustained cranial trauma as well as a broken 12th vertebrae and a lesion of the spine. We gave the doctors TM1's personal information then made a list of people to call in order of importance:

Their parents

Snowcard travel insurance

People back at camp

Leeds Student Union

I phoned TM1's mum and told her that they had had a fall and were now in hospital, and had been diagnosed

with cranial trauma and a lesion of the spine. I then put her onto TM1's neurospecialist, Dr Marco Maloni, who explained the injuries in more detail.

At this point it became apparent that TM1 may not walk again.

We stayed the night at the hospital; TM1 got transferred from A&E to intensive care where their head trauma could be monitored for swelling.

In the morning I drove to pick TM1's parents up from the Milan Malpensa Airport. Then took them to the ward.

TM1's condition had stabilised and they was now fully responsive but required sedation for the pain. They still weren't fully aware of what happened and hadn't been informed of the long-term impacts of their injuries. To those who weren't directly involved we told them that TM1 had injured their back and we did not know how long they would be in hospital for. And in accordance with the family's wishes we requested that no-one discussed the incident on social media. The family took over dealing with the travel insurance, and we kept the union updated.

Incident Report TM4

Incident occurred at the last pitch; TM1 had gone on ahead after the pitch before to rig a hand line to the descending bolts. TM5 and I met them there while they finished rigging the hand line. While TM5 and I waited just before the pitch, TM1 used their cowstails to wait on top of the pitch for TM2 and TM3 to arrive with the other rope. Once they arrived TM3 handed TM1 the other bag, who then rigged the pitch before attaching their fig 8 to the rope. At some point TM6 arrived at the bottom to watch our final descent as you could get there without having to enter the water. TM6 and TM7 had been climbing in the same area. TM1 then unclipped their cowstails, from what it seemed there was no friction or slowing of any sort as they fell but they were holding the dead rope, suggesting the rope had not been rigged properly. They fell around 10m down the horizontal smooth part of the pitch before hitting the rocks and then entering the water unconscious. TM6 didn't seem to realise what had happened or was not looking, but we then called and shouted to TM6 to enter the water and get TM1 out. They did, pulling TM1 onto the rocks below the pitch, where we were unable to see. TM3 rigged, using another rope and descended. TM2, TM5 and I remained at the top of the pitch until TM1 gained consciousness.

TM2 then re-rigged the pitch for a pull through. I then descended to find TM1 lying on the rock with TM3 supporting them. TM6 had left to get help. TM1 was conscious but words slurring and not making sense, they kept trying to move and suggesting their back hurt. TM5 then descended, then TM2. I noticed the whole rope was down in the water with TM1's fig 8 still attached. There was no visible blood apart from a bit coming out of their mouth. Their neoprene jacket had been unzipped and their harness unbuckled. They were moving their upper body but not their legs. Once we realised their back/spine could have been damaged, we decided that I should go back to the van to find TM6 and explain the situation. I left down the canyon for about 2 minutes before finding TM6, I explained to them the believed injures. They said that they and TM7, who was waiting down the canyon before the incident, had alerted the rescue team, but there was difficulty due the language barrier. They said that I should go and get TM5 who was able to drive the MPV into town, and that they would go back and tell the emergency services of the information. I returned to the scene and told the information to the rest of the team.

TM5 and I then left down the canyon before running into TM6 who had found what seemed like a group of rescue/experienced Italian canyoners. After being aware that an emergency had happened they too had called for rescue. They went up the canyon to help, while TM5, TM6 and I returned to the MPV where TM7 was. We got to the MPV with the time from the incident occurring estimated at around 45 minutes. TM5 and TM7 then left to alert the others back at camp and to get TM1's insurance details. TM6 and I waited at the car park, for them to return while seeing emergency services and rescue teams drive past. After what seemed about an hour, TM7 and another club member returned. We then waited, being told by some of the Italian canyoners that help had arrived and a doctor was at the scene. Helicopters then came and left before emergency service men informed us that TM1 had been taken to hospital.

Incident Report TM5

After going down the previous pitch TM1 continued on to the next pitch with a tackle sack to rig the traverse line of the next pitch. By the time I arrived to the next pitch TM1 was hanging on their cow's tails just above where the rope was to be for the next pitch, finishing rigging the traverse line. We waited a while for TM3 and TM2 to come with the tackle sack which contained the rope for the next pitch. When they arrived, I took the tackle sack off them and walked it over to TM1 using the traverse line, so they could rig the next pitch. They started rigging the next pitch but couldn't tell if they had used enough rope so TM6, who was waiting for us at the bottom of the pitch, helped TM1 get the right length. Once TM1 had got the right length I believed they rigged a pull through. I watched TM1 attach their figure of 8 descender and start to take of their cow's tails. First their long one then their short one which they had a bit of difficulty doing due to not having the right footing and their weight being on the shorter cow's tail. They eventually managed to get it free and went to start descending. But instead of descending they fell, rope going down with them and hit the slope of the rock face a couple of times on the way down and ended up lying face up in the pool of water at the bottom of the pitch. We all started shouting their name, then TM3 shouted at TM6 to get them out of the water. I saw TM6 dive into the water and turned around to move off the traverse line so TM3 could get on it to go down and help. I waited at the top of the pitch for a while out of view of everything. TM2 then went to re-rig what TM3 had rigged to get down to TM1, after he had re-rigged it TM4 went down first. After they had descended and told me "rope free" I then went onto the traverse line and then descended down to the bottom where TM3 was trying to support TM1's back. I stayed there for a few minutes but TM1 kept trying to move complaining their back was hurting so we tried to find them somewhere flat and more comfortable to move them to but as we couldn't see anything easily accessible in the vicinity TM4 went swimming further downstream to see if there was anywhere better. But there wasn't so they came back and told us so. After TM2 had descended we took of all our life jackets to use to prop TM1 flat so they were comfortable. While doing this we decided to send TM4 on further ahead to tell TM6 ,who had left to call for help, that we believed TM1 possibly had issues with their spine. They left for a bit while we rearranged TM1 but came back to tell me I had to go drive the MPV back to camp. So I left going downstream, while doing some boulder hopping I hit my ankle badly which caused me a lot of pain but TM4 waited for me till I could continue on, which was quite slow progress, we ran into TM6 who was talking to a guide about the situation while 4 men were going upstream to help. I continued on to the MPV and once I arrived I drove it back to camp with TM7 to collect items for TM1 and to tell/update another group member on the situation.

Incident Report TM6 – canyoning accident, 10/06/2017 (written on 14/06/17)

TM7 and I had just finished climbing near to Pilotera canyon at around 5pm, where a group consisting of TM3, TM4, TM5, TM2 and TM1 were canyoning for the day. We walked over the big bridge near the end of the canyon and waved to them as they approached the last pitch. I then ran down to the bottom of the hill and up the canyon to the last pitch where TM1 was rigging. They had already rigged a retrievable traverse line to the head of the pitch. They had their cowstails clipped in (as I recall, with long into the fixed bolts and short into the traverse line) and was beginning to rig the abseil. They were paying out the rope. I told them to coil the rope then throw it down to set the length rather than just flake it down the pitch, and they did. I saw them begin to rig the biner block, the standard canyoning technique for rigging a retrievable non-releasable abseil used by professional canyoners all over the world. I could not see in detail any of the rigging that was going on because TM1's body was blocking my view. They then rigged their abseil device, a figure-of-8. I turned away for a second, and then looked back to see TM1 in free fall down the pitch, bouncing off 2 ledges and clearly hitting their head before landing in the pool at the bottom. The pitch rope was also in the pool at the bottom. It had been a complete free fall.

For a couple of seconds, I was in total shock about what had just happened. I did not understand how they had fallen and found it hard to believe that they had actually fallen at all. I was brought back to reality by TM3 yelling at me: '****** get in there and help them!' Immediately I jumped into the pool and swam over to TM1. Their body was totally limp, and they were unresponsive to me grabbing them. I swam with them, supporting

their head and trying to open their airways. Their teeth were clenched tight shut. They were cross eyed and blood began to come out of their mouth. I shouted to them that we were going to make sure they were ok and that we loved them. TM3 then abseiled down on a fixed line to assist me in moving them, as they had a full wetsuit and buoyancy aid on whereas I was only wearing my shorts and pink hat. All of this had happened over the course of around 2 minutes since TM1 had fallen. TM3 and myself then began to move TM1 out of the water and onto a shelf of rock at the side of the pool. As we did this TM1 regained consciousness and started to thrash their arms very powerfully, making incoherent noises. They were clearly in a lot of pain, but I was extremely relieved that they were breathing and had mobility in their arms and neck. As soon as TM3 and myself had moved TM1 out of the water I started to move off fast (but with great care not to hurt myself) back to the MPV to ring the emergency services.

I found TM7 sitting at the exit point from the canyon to the path back to the carpark. I shouted to them that TM1 had badly injured themself and that we needed to get help, and TM7 quickly put their shoes on and followed me. Once at the MPV I found the keys, unlocked it, and moved to find TM3's phone because I knew that they didn't have a passcode. I was not carrying a phone at the time. I found the phone and TM7 arrived. We looked at the information board for Bodengo 2, the neighbouring canyon, which said that in case of emergency you should telephone 118. I called it, but went to an answerphone. Frustrated, I tried again whilst TM7 did the same on their phone. TM7 finally got through and began to report the incident to a woman, having asked for the ambulance and an English speaker.

As this was happening I saw an elderly man approaching in a car, who TM7 and I had said hello to on the walk back from our climb while he was strimming his lawn. I stood in front of the car and waved at him to stop. He pulled over and I explained to him using a mixture of Italian, English and gesturing that TM1 was seriously injured in Pilotera canyon. He parked his car and got out. I had stopped him because I was aware that Italians do not always speak good English and thought that having a native speaker to communicate with the emergency services might be helpful. TM7 was speaking to the woman still and did not seem to be able to communicate very easily with her. We were trying to explain that TM1 was in Pilotera canyon with a serious head injury and needed evacuating to hospital as soon as possible. The woman could hear the man speaking Italian and asked for him to be put on the line. He then spoke to her for about 30 seconds. I am not sure what he said to her, but I believe he tried to explain that TM1 had a serious injury and was in a canyon. He then gave the phone back to TM7, who continued to try with English. The man then wished us well and left. The woman began to ask TM7 for some coordinates of TM1's location, which we did not have as there was insufficient signal in the valley to use Google Maps. The phone call then ended with the woman saying that they would send an ambulance to our location and assess the situation further from there, in spite of us saying that they would definitely need a helicopter and stretcher as we could not move them. I am not sure of the full exchange on the phone. The phone call had lasted about 15 minutes, meaning that TM1 had been injured for about 20-25 minutes. We then agreed that TM7 would stay at the carpark and wait for the ambulance while I would go back and get TM5 to come up and drive the MPV back to the campsite with TM7.

I went back down to the canyon. On the way down, I heard some voices in Bodengo 2 so went there to see if anyone there could help. I met some German tourists waiting for their friends to finish a guided trip in Bodengo 2. I explained to them in English what had happened and asked if they could tell the guide of their group what had happened to TM1 so that he could help. They agreed to tell him as soon as he had finished ensuring his clients all did the final jump in Bodengo 2 safely and I went back up Pilotera to regain contact with the group. Before the final pitch, I encountered TM4 who told me that TM1's legs were not moving. TM3 and TM2 were ensuring that they did not move their spine in case they damaged it further. I said to TM4 that they and TM5 should come up to the MPV and that the guide from the other canyon would be coming to help soon. I headed back to the exit path to meet the first guide, an Austrian, and 4 other Italian guides. One of them confirmed that he had also phoned the rescue. We went back up to the car park and TM7 and TM5 headed off in the MPV back to the campsite to relay the details to the rest of the group and get TM1's insurance and next of kin details. It was between 6-6:15pm when they left.

TM4 and I waited at the carpark for around 2 hours, occasionally speaking with the rescue team about what was happening but mainly keeping out of the way. Just after the MPV had left, the canyon rescue team turned up in individual cars. One of the rescue team also told me a helicopter had been sent for. One ambulance and one alpine ambulance turned up. I was informed by one of the rescue team that there were in fact 2 rescues in the canyon that day, though I am not sure if this is correct as it could also just have been that the same incident was reported twice (by TM7 and by the canyon guides). At around 7:15pm another club member and TM7 turned up in the MPV. We then waited for around another half hour for TM3 and TM2 to return from the canyon, and 10 minutes or so after this the helicopter departed with TM1 on board. The rescue team then returned any equipment that we had abandoned in the canyon to us. We got the all-clear from the medic and controller that we should leave after being told that TM1 would definitely be going to Gravedona hospital. One of the rescuers who spoke good English also informed us that the emergency services number had changed a few weeks ago, from 118 to the international emergency services number 112, quoted in numerous mountain sport guidebooks including Canyoning in the Alps.

Reflections and Potential Learning Points, TM6, written on 28/06/17

As someone who was not on the trip, I must emphasise that I cannot envisage that, had I been a member of the team that day, I would have done anything differently which would have prevented the incident. TM1 is an experienced, strong and careful canyoner and caver who is competent and confident with rigging non-releaseable pullthrough systems. In the earlier canyons that week (Esino Inferiore especially) htey really impressed me with their awareness, initiative, leadership and strength in the canyon. I would trust them to rig safely and competently in caves and canyons alike and they have demonstrated to me their ability to do so on all trips preceding this one where I had been present. Despite not having caved or canyoned with TM1 as much as others in ULSA, due to my year away in New Zealand, I have great trust in them as a team member and as a friend and would without question have trusted them to rig safely and competently unsupervised.

1. Even the best practitioners amongst us make mistakes. It is deeply unfortunate and upsetting that this particular mistake had the consequences that it did, but I believe that it was an unforeseeable accident which the team members could have done very little if anything to prevent. It is unclear what exact mistake caused the accident and I think it unlikely whether we will ever know exactly what happened. I didn't notice this at the time, but I am informed by other team members who remained at the scene of the incident longer than myself that their descender was attached to them and was rigged correctly to the rope. I do not know whether at the time they determined if it was rigged on the live or dead rope, but I did not determine this myself at the time and have had no conclusive confirmation that it was rigged on either the live or the dead rope. This leads me to determine two possible scenarios which lead to the incident:

    - They had attempted to abseil on the dead rope (on the wrong side of the biner block).

    1. The biner block itself was rigged incorrectly.

- There are a number of methods to mitigate against people attempting to abseil on the dead rope. These include:

    - Managing the rope neatly so that the dead rope remains packed away in the tackle sack at the pitch head with only the live rope hanging down the pitch, making it clear which strand of rope is to be used.

    2. Ensuring that everybody tests their descender with a long cowstail in as a back-up before they descend the pitch.

3. Using a canyoning quickdraw (like a climbing quickdraw but with screwgates at each end) to attach the blocking device (biner block, alpine butterfly krabbed to the live rope, figure-of-8 block etc) to the pull-through anchor as a back-up so that either strand of rope can be safely abseiled on. In addition to this, having the most experienced team member act as a 'controller' at the pitch-head who removes this redundancy feature before they abseil and de-rig the pullthrough.

8. Point 1 was standard mode of practice for us in the canyons. Point 2 was also standard practice, as it would be in caving. Point 3 was often only done if the rigging in question was the releasable figure-of-8 block, but could actually have been applied to all of our pull-through rigging. Not many members of the club were carrying canyoning quickdraws or were aware of their potential uses as they are not commonly used caving. In my opinion, one potential learning point is better educating club members on the use of canyoning quickdraws in pull-throughs and ensuring that more club members carry them in canyons.

9. Having an experienced team member at the pitch head to check that everyone is following safe practice is another way to mitigate against this, but I feel that strict rules regarding this are not in keeping with the ethos of university caving, which is ultimately about improving people's confidence and leadership ability by allowing them to establish their own self-awareness of what they are comfortable with. At the end of the day, we are a group of friends who want to have fun together, not a guiding company. The mode of passage through a cave or canyon of a particular group depend on the experience of that group and pitch-head practices were adjusted accordingly. In this particular case, for the reasons I outlined at the beginning, this point is hard to apply in this incident as TM1 was an experienced practitioner and had the trust of all concerned, including their own, to rig their device on the live rope correctly and safely.

10. There are a number of ways that a biner block could be rigged unsafely and fail. The two most likely I can think of are:

    2. Tying an Italian hitch or other similar hitch/combination of twists which do not self-tighten under load, therefore potentially causing free-fall on descent.

    3. If not using a twist-lock or triact karabiner (the use of these is recommended), then failing to do up the gate correctly and then not ensuring that the clove hitch is tied on the spine of the karabiner could, once the karabiner is loaded, cause the knot to slip round and cross-load the gate, potentially leading to failure.

- The biner block was not inspected by anybody but TM1 (as far as I am aware it was not observed on the rope after the incident). Therefore, it is not possible to know which, if any, of these faults were present in its rigging. This for some people seems to have lead to doubts about the safety of the technique, which I can empathise with as it is not commonly used among cavers. However, I would argue it is no more unsafe than the 'conventional' alpine butterfly krabbed to the live rope, which can also be rigged incorrectly in a moment of human error. Both techniques have inherent advantages and flaws that I know of, which I have outlined below:

Alpine butterfly krabbed to the live rope:

Advantages:

4. Can be rigged around natural pull-through anchors (eg thread, tree) and artificial (bolted) pull-through anchors safely.

Disadvantages:

5. Can be very bulky and awkward to pull down under certain circumstances due to greater likelihood of getting caught on the anchors and natural obstacles and friction between the live rope and dead rope.
6. Slower to rig and adjust and more difficult to untie once loaded than a biner block.

Biner Block:

Advantages:

7. Very quick and simple to rig and adjust; very easy to untie after loading.
8. Ensure a very easy pullthrough with very little chance of getting caught compared to an alpine butterfly krabbed to the live rope.

Disadvantages:

9. Cannot be rigged around a natural pull-through anchor (eg thread, tree).

4. As can be seen, both techniques have scenarios where they will be the most obvious choice to rig with. In the presence of bolted anchors, I personally would argue for the use of the biner block every time as I feel it provides much greater certainty of not getting caught pulling through and is much quicker and more efficient to use. I have experienced a number of times when I have used an alpine butterfly krabbed to the live rope where pulling through has been much more difficult than I would anticipate in a similar situation using a biner block (including on the holiday in Esino Inferiore), so personally prefer the biner block.
5. There are a number of other possible factors which may influence which is preferable to use. Ones I can think of are:

10. *Alpine butterfly krabbed to the live rope primarily relies on the strength/integrity of the rope, which may be greater/more reliably known than a karabiner.* I have not seen any formal testing of the different techniques under load, and am not sure that any has been conducted for comparison. It would be an interesting test.
11. *The technique of the alpine butterfly krabbed to the live rope is more widely known among cavers.* I have made efforts to teach members of the club how to use biner blocks effectively and safely after having learnt about it whilst canyoning in New Zealand, and if the technique is well known and practiced by the user and they are confident using it safely (which is the case for a number of club members who were on the holiday) I see no reason for them not to use it in the canyon or cave. Ultimately, an individual should use their disgression to judge which technique they are most comfortable using in a particular situation.

To conclude, my suggested learning points are:

- Ensure that the biner block and its uses are taught alongside already known caving pull-through techniques to members of the club.

3. Ensure that the use of a canyoning quickdraw in pull-throughs is taught to members of the club.

4. Ensure that all members of the holiday know the procedure to follow in case of an accident, including that the emergency services number for mountain rescue services in continental Europe is **112**.

5. In a broader sense, ensure that everyone remains positive about the activities that we do as a club and are happy and comfortable undertaking all activity with the club. At the end of the day, what we do should be about having fun together safely as friends.

Appendix B – Teaching Information about Stress

It should be noted that the teaching information presented below has been developed from open water and cave diving scenarios, however in a general sense are applicable to the field of caving. Minor modifications have been made to make the text more applicable to a caving.

The 'Incident Pit' concept has been developed as a teaching tool about the dangers of stress. This concept identifies that incidents rarely happen as the result of just one factor, but are often the result of a combination of factors. In isolation these factors may be minor, but as the combination builds, the stress on the person increases more rapidly until it exceeds their ability to cope. This can be visualised as a 'V'-shaped pit, with exponentially steepening sides, making it easy to get both in and out of at the top, but once in becomes increasing difficult to escape.

The CDG teach the concept of not exceeding your personal stress limit. Stress affects people differently, therefore everyone needs to be aware of their own personal limit for coping with stress. This limit can be extended by training, practice and experience. If exceed, a person will become stressed and may not be able to deal with problems that would otherwise be routine.

Analysis of UK cave diving incidents by the CDG has identified direct and indirect stress factors that are applicable to caving. Direct stress factors include:

- Time pressure,
- physical stress, and
- peer pressure.

While indirect stress can include:

- being stuck in traffic,
- rushing to make up for lost time,
- problems at work, and
- problems at home.

Signs of stress may include:

- Faster movement.
- Loss of technique
- Inability to execute routine drills
- Reduction of environmental awareness
- Fixation on one element of the trip

If stress levels rise above an uncomfortable level the solution is to stop and reassess the situation. If you still feel sufficiently in control you can continue, otherwise you can make a controlled exit if safe to do so, or in a caving scenario tasks can be delegated to other members of the group.