Underwater Speleology

Journal of the Cave Diving Section of the National Speleological Society

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July August September 2012

Do Extraordinary.

People do not decide to become extraordinary.
They decide to accomplish extraordinary things.

- Sir Edmund Hillary

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Featured Articles

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Issue	Deadline
Jan/Feb/Mar	December 1st
April/May/June	March 1st
July/August/Sept	June 1st
Oct/Nov/Dec	September 1st

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Please submit letters and articles to UWS EDITOR, 295 NW Commons Loop, Suite 115-317, Lake City, Florida 32055.

Editor's Notes

98% of the people who get the magazine say they read the cartoons first - and the other 2% are lying. ~ David Remnick

My "Notes" were cut from the printed issue to make room for articles. I am sure this is appreciated as you would rather read more articles than what I have to say.

The 2012 Workshop was tremendous. Thank you for all your hard work Bobby Franklin, 2012 Workshop Chair, and thanks to all those that helped to make this Workshop such a success.

A review of the Workshop begins on page 32. I want to thank everyone who sent pictures, there were so many I couldn't possibly fit them all in the printed version, but have included many more here in the online issue. Check them out.

The Midwest Workshop is set for September 15, 2012. Not all of the details are worked out yet, check back at the NSS-CDS website for more information as it becomes available.

You will notice a few changes and additions to this issue; updates and new ideas. Chris Hill and his Midwest perspective is now a regular column, *Midwest Underground*. I look forward to future columns.

We are also welcoming a new sidemount column, *On the Side*, with Rob Neto. With the current popularity and interest in sidemount diving, I am sure we will all find something of interest each issue.

For those of you who come to the web-version of UWS to check out any extras I may have included, I have an addition. A little fun each issue to test your cave diving trivia, and this time it is "Name Those Fins."

Can you name the diver in the cavern shot on page 24? I will send a beautiful CDS coffee mug to the first CDS member who e-mails me the correct answer….. and just to make it interesting, I will fill that mug with coffee if they can name the diver in the other two shots on that page as well.

While you are here, check out the rest of the NSS-CDS website. It is truly under-used by members as a source of information.

Enjoy and Safe diving,

Cheryl

from the Chairman

gene melton

"Do not fear mistakes. You will know failure. Continue to reach out." Benjamin Franklin

If you know of someone who thinks they should be receiving UWS and they are not, have them contact NSS HQ and verify their address and membership information is correct. The UWS mailing list is printed from the address information in the NSS database. There were 24 returned magazines from the last mailing.

On behalf of the membership, I would like to thank Richard Blackburn and Rick Robinson for serving on the BoD. I would also like to welcome the two new Board Members, Bill Huth (Treasurer) and Tony Flaris (Secretary).

The workshop at Suwannee County High School was a success. Bobby Franklin did an outstanding job of making everything come together at the end. On Wednesday, basically 2 days ahead of the event, a question arose about the event insurance. It was not until mid-Friday that all was determined to be OK and that we had a facility for the workshop. Sometimes the small print is important.

The Mid-West Cave Diving Workshop is September 15th in St. Louis. See you there.

The NSS Convention, Mayacon, is June 25 -29 in Lewisberg, West Virginia. See you there.

Next year's workshop has been confirmed for Wakulla County High School. Chris Wickman (850-566-9026) is the workshop Chairman. I just spoke with the Wakulla Springs Lodge. They have a total of 27 rooms. The group discount rate is $85 per night. We have all 27 rooms reserved for Friday and Saturday night. Currently there are 24 rooms still available. Please contact me (gmelton@hs-eng.com) if you wish to add your name to the list. There will be two social events. One will be held at Wakulla Springs State Park and the other hosted by Wakulla Dive Center. Although they were not able to attend, the Wakulla Dive Center was a sponsor of this year's workshop.

An item for you to put on your calendar for early next year; we are working with the Wakulla Dive Club on a joint social event in the Wakulla area in late January or early February 2013. The planning and details are developing as I write this column. The goal is to make this a social, clinic and diving event. Check the NSS-CDS website for details as they develop. I am encouraging all NSS-CDS members and their friends to attend both Wakulla area events.

We still have to vote on the by-law revisions. The NSS-CDS website has been revised and the on-line voting system set up as of June 5, 2012. A notice is published on the website and in the UWS on the opposite page with instructions on how to vote. This way we are saving the expense of printing and mailing post cards.

Cheryl Doran is now the Advertising Manager for UWS. If you are interested in placing an advertisement in UWS please contact Cheryl.

All of the chapters for the Cave Diving Manual have been received. Jeff is in South Africa and will be back late June. Our new goal is to have the revision available by the end of the summer. Anyone interested in placing an advertisement in the revised manual please contact the UWS Advertising Manager, Cheryl Doran.

Dive safely,

Gene

VOTING

Proposed Changes to NSS-CDS Constitution and By-Laws

Membership voting for proposed changes to the NSS-CDS Constiution and By-Laws will take place on-line.

Proposed changes were posted in the January/February/March issue of Underwater Speleology and can be reviewed on the NSS-CDS website at : **http://nsscds.org/content/bylaw-and-constitution-proposed-revisions.**

Members of the NSS-CDS in good standing have until midnight (Eastern Standard Time) August 15, 2012 to cast their vote at:

www.nsscds.org/vote.php

Resonance During The Indian Spring (1991) Cave Collapse?

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Fig 1. A map of the southeastern United States showing the location of the water-filled Indian Spring cave. The cave spring water ends up in the spring pool which eventually empties into the Wakulla river. Figure adapted Nof and Paldor (1).

Introduction

This article is a layman version of a scientific paper that just appeared in the *Journal of Forensic Science* (Nof, 2012). We apply familiar fluid dynamics principles to the situation that occurred in the cave in 1991; we do so on the basis of interviews with four out of the five surviving cave divers. We dissect their testimonies to arrive at a physically plausible scenario determined on basis of a fluid dynamics application to the natural flow in the cave, the flow induced by the compressed air released by the divers, as well as the mudslide. Aside from showing that resonance was probably responsible for the collapse, we find that there was a temporary flow blocking during the collapse but no total flow reversal within the cave.

a) *Background:* The Indian Spring cave is situated in the panhandle in north Florida (Figs. 1, 2). Like many other submerged caves in the region, it was explored primarily in the eighties and nineties. A bizarre accident occurred in 1991 when the cave collapsed while two divers were still in it, causing the drowning of a very experienced cave diver, Parker Turner. To date, this is the only cave diving accident in cave diving history (out of several hundred), which is said to occur due to natural causes rather than diver error.

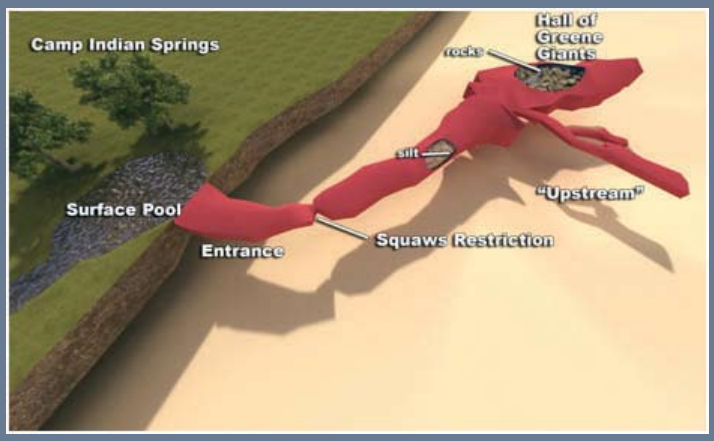

Fig 2. A schematic three-dimensional view of the Indian Spring cave. The cave walls, ceiling and floor are all shown with the red envelope. Limestone is outside that envelope whereas water occupies the inside of the envelop (the cave). Our proposed collapse mechanism involves resonance in the region downstream to the Squaws Restriction. That resonance increased the pressure in divers-induced air pocket (in the cavern region) beyond the level that which the cavern's ceiling could sustain. As a result, part of the ceiling fell on the steeply sloped sediment, which, in turn, slid and blocked the Squaws Restriction (see Figs. 3, 4, 5). Adapted from Nof and Paldor (1).

The most important issue that is addressed in Nof (2012) is how the proposed physics fits what has been actually observed by the cave divers present in the cavern during the accident. Previously, we were not in a position to speak to those who witnessed the event directly because, understandably, without seeing an article that already appeared in the scientific literature, they were very reluctant to talk to us. By sharp contrast, after the appearance of the Nof and Paldor (2010) article, the divers provided a wealth of useful information, which helped shed more light on the processes in question. Much of the present article is based on the information that they provided and on questions raised by that information.

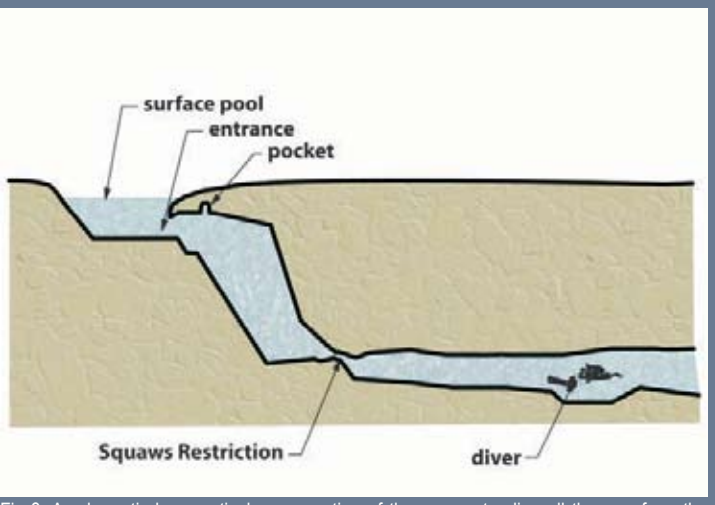

Fig 3. A schematic long vertical cross-section of the cave extending all the way from the entrance to the Hall of Greene Giants situated a few hundred meters within the cave.

For instance, did the collapse cause an actual *reversal* of the flow within the cave as originally claimed in some of the blogs? We shall argue that what was actually observed was most likely only a partial reversal (i.e., a reversal of the flow near the bottom), not a complete reversal in the entire water column. Similarly, surface support personnel claim that the water level in the basin dropped one foot in 10 minutes. Was that because water flowed back into the cave? We shall suggest that this drop was simply because the spring flow was temporarily blocked so the water exiting the basin

downstream (Fig. 3) had no compensating inflow coming in upstream so it drained the basin fairly quickly.

Why was sediment typical for the cavern zone found 500-700 feet into the cave if there was no flow reversal? It is argued that this is because of the nature of the mudslide flow. While the heavy, muddy water flows in one way (downhill), there is a compensating flow above (of the clear water) flowing in the opposite way so there is no net exchange across a complete cross-section.

For clarity, we define four different stages of the collapse process (Fig. 4). During the first (or initial) stage, a resonance is established in the pocket, the pressure rises uncontrollably and the limestone in the immediate vicinity of the pocket breaks. During the second stage, broken debris fell on the slope below which cause the mud to slide creating an initial cavity in the sloping bottom. In the following third (or intermediate) stage, the sediment initially contained in the cavity establishes a lens-like turbidity current that rushes quickly downstream, blocking most of the restriction shortly afterwards. In the fourth (terminal) stage the smaller lens-like turbidity current (whose top was effectively "sliced off" by the restriction) propagates more slowly downhill beyond the restriction.

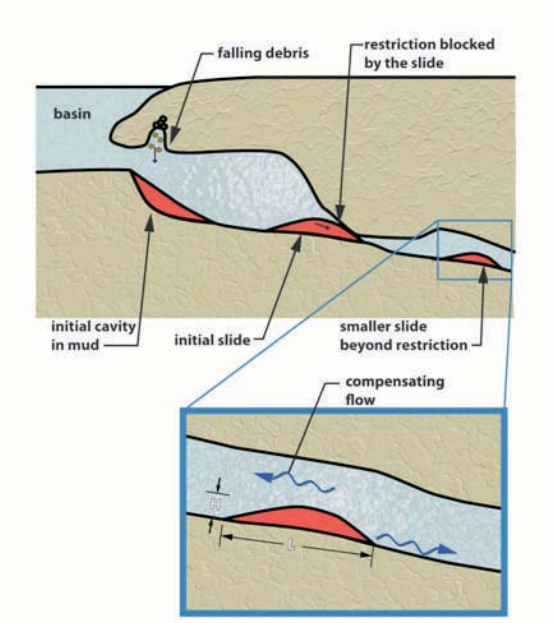

Fig 4. A schematic short vertical cross-section of the cave extending from the entrance to a short distance beyond the restriction (politically incorrect named the Squaws Restriction).

b) *The event as perceived by the cave divers*: The particular dive in question was one of many exploratory cave dives conducted by various groups (during the last fifty years) in the Wakulla county area (Fig. 1). It was executed by what, at the time (80's and 90's), was probably the most organized, sophisticated and accomplished cave-diving group in the world, the Woodville Karst Plain Project (WKPP). They set several world cave diving records in terms of penetration distances and times spent underwater, mapping submerged caves that are roughly 10 miles long, staying at depths of 200-300 feet for nearly four hours (on one dive) and decompressing for as much as 10 hours or more.

There were three teams in the cave and cavern system on the day in question. One team (Bill Gavin and Parker Turner) did the deep and long exploration dive in the cave, while a second team (George Irvine and Lamar English, diver A and B) did a scooter dive. A third team consisted of Bill Main and Alexander Kaye (divers C, and D). Both the second and third team were already doing their decompression stop in the cavern when the first team, which was the last to exit, encountered the avalanche within the cave. We spoke to all the divers mentioned above with the exception of Gavin, who indirectly indicated that he is not willing to speak to us.

Evidently, as part of his decompression, diver A stuck his head in one of the air/gas pockets in the cavern at a depth of 15-20 feet. This is a common practice among cave divers who do it routinely either to get warm or to blow their noses and clear their sinuses. His scooter was not with him at the time but rather was tied to the guideline below. After a few minutes, while his head was still in the pocket, the avalanche started from the very same pocket that he was in. As a second step, broken rock and debris fell from the ceiling onto the steep slope below, which, in turn, developed into a mudslide that resulted in the blockage of the first downstream restriction (politically-incorrectly named the Squaws Restriction).

In contrast to common anecdotes implying the involvement of a scooter (peculiarly persisting among cave divers for two decades), no scooter was involved in the collapse as both scooters were tied to the line below the divers. Note, however, that, at some point, diver A thought that his scooter, which he left tied to the line below his decompression position, was turned on accidentally and ran away but it turned out that this was not the case. Anecdotal claims that a seismic event might have contributed to the collapse are also unsubstantiated. According to the seismic records (http://earthquake.usgs.gov/earthquakes/eqarchives/epic/epic_global.php), a total of 137 quakes were recorded worldwide from 11/16-11/18, 1991 but none were even close to Florida.

Evidently, surface personnel witnessed a sudden drop of the water level in the basin (one to two feet within ten minutes or so) as well as swirling water above the cave entrance, and interpreted these to mean that the flow in the cave had totally reversed its direction. Technically, this is in general feasible and indeed, Lake Jackson, situated in northwest Tallahassee (Fig. 1) about 20 miles to the north of the cave (and within the same karst aquifer) has occasionally disappeared (almost overnight) during the last fifty years. Presumably, an underground passage opened up, draining the lake. (In most occasions, the lake came back after several years but its last disappearance in the late eighties has not seen a reversal.)

While such a sudden opening of a previously closed underground passage is technically possible, it is extremely unlikely that it would happen just when the cave divers happened to be within the cave. We employ here the same logic that we used earlier—it is unlikely that a cave collapse just accidentally happened to occur while divers were in the cave. A much more likely scenario was that the sudden drop of water level in the basin is simply because the cave exit/

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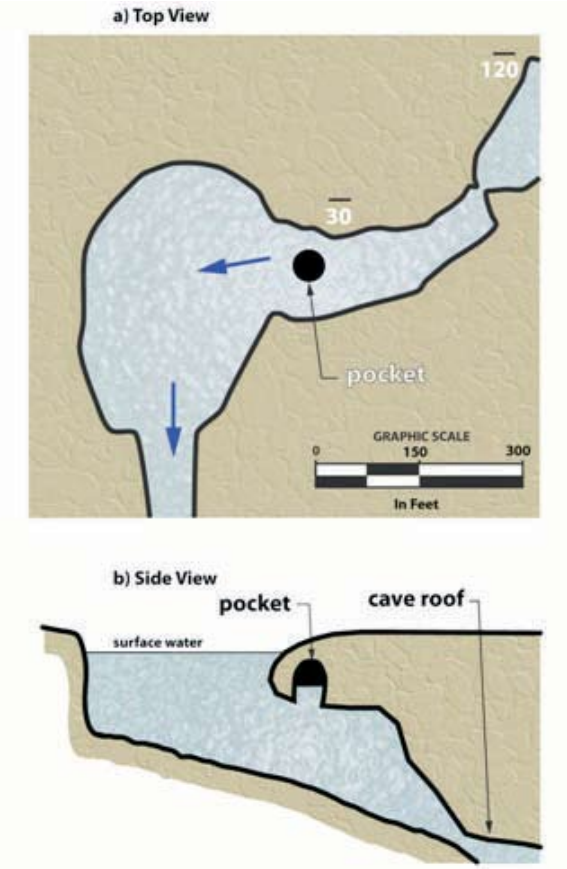

Fig 5. The position of the pocket (black solid circle) relative to the basin and the restriction. Numbers with a bar above them indicate the depth of the cave ceiling. Side view is schematic, it is not drawn to scale.

Continued from page 8

entrance (exit to the water, entrance to the divers) was temporarily shut-off (so there was no flow out of it) whereas the downstream exit of the basin remained opened, quickly draining the basin. Taking the average volume flux out of the cave to be roughly 150 cubic feet per second, and the surface area of the basin to be 300 x 300 square feet, we find that the water level would drop two feet in just 17 minutes if the feeding tunnel were to be abruptly shut down. As we shall see later, we attribute the observed swirl to a horizontal vortex that initially formed above the cave entrance when the mudslide just occurred.

This article is organized as follows: we first present the basin-pocket resonance model and then the mudslide calculation. Afterwards, we address the resulting turbidity current issue, and then the vortex in the open ocean.

The basin-pocket resonance model

Consider again Figs. 4 and 5, and the U-tube shown in Fig. 6, which represents the situation shown in Fig. 5 in a simplified manner. In contrast to the Nof and Paldor (2010) U-tube problem (see their Fig. 6), our new resonant U-tube configuration contains only one narrow vertical tube capped at its top (shown on the right of our Fig. 6). The left tube in Nof and Paldor (2010) is represented here by the broad basin, which is, of course, open on its top (Fig. 6). The narrow tube on the right represents the pocket in the upper regions of the cavern where the compressed air/gas accumulates (see Fig. 5).

This new U-tube model is adopted as a means of representing resonating flows that are superimposed on the usual one-dimensional (horizontal) flow in the cave. The modeled resonating flow, which is induced by the air/gas pocket, is limited to the region between the pocket and the basin, so the lower part of the modeled tube is taken to be blocked on the two sides, forming a U-tube with one sealed vertical component (pocket) and one open (basin).

When the water level in the right vertical tube (shown in Fig. 6) is elevated an arbitrary infinitesimal distance above its neutral position, there are two restoring forces. The first is the familiar weight of the displaced water. The second is the new not-so-familiar force due to the incremental increased pressure in the air-filled section. This new force (i.e., the incremental increased pressure times the cross sectional area) turns out to be linear. In the absence of friction (i.e., in a purely inertial world where mechanical energy is not converted into heat), the sum of these two forces causes the fluid to accelerate (in both the horizontal and vertical tubes as well as the infinitely large basin) in response to the initial perturbation (e.g., increase) of the water level in the right vertical tube.

Just like a swing is forced higher and higher when pushed at the same frequency as its natural oscillation frequency, so are the oscillations in the U-tube. Accordingly, the period of the forcing leading to a resonance is given by equation (2) in Nof (2012). This formula gives values that are approximately 40% larger that the period obtained by Nof and Paldor (2010) because there is only one narrow tube and one chamber of compressed air/gas so there is less of a restoring force and, consequently, the water moves more

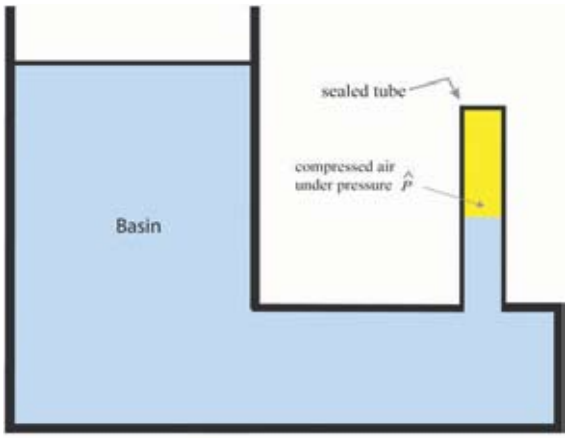

Fig 6. Schematic diagram of the U-tube model with one narrow (right) and one thick (left arm). The thick (uncapped) arm corresponds to the basin whereas the thin (capped) arm corresponds to the pocket.

slowly. When the forcing is at the above period, the pressure at the gas-filled chambers goes (theoretically) to infinity. It is this infinite increase in pressure that we argue might have caused the collapse. Note that, practically, the variation in the water height inside the tube ranges from almost zero in the beginning of the resonance process to the full extent of

the gas pockets when resonance takes hold. For most Florida caves, this maximum length might be as high as a few inches or several feet.

We shall now consider the case (Fig.7) applicable to the Indian Springs cave dimensions. Given the simplifications in the model it is, of course, very hard to pick up values for the various parameters but some rough guesses can be made. Accordingly, suppose that the ceiling of the cavern/cave where the pocket was identified (Figs. 4, 5) is about 15 feet below the water elevation in the spring run (typical decompression depth), that the length of the compressed gas pocket is two feet and that the combined length of the cavern/cave and vertical tubes is 150 feet. For these values, the period is about 4.5 seconds, which is of the same order as the time elapsing between two consecutive breaths of a typical diver during decompression. We see, therefore, that the forcing period corresponding to resonance (i.e., the pressure in a typical cave becomes infinitely large) is comparable to the natural breathing period of divers in the cave.

The mudslide

As mentioned, we suggest that resonance caused an uncontrollable pressure rise within the pocket, leading to a breakup of the limestone surrounding the pocket. A massive amount of broken rock then fell on the steeply sloping bottom below. Given the high slope of the bottom (~ 30 degrees), it was probably only marginally stable to begin with so, upon impact with the broken rock, a mudslide occurred. A lens-like feature was carved out of the slope turning into a turbidity current downhill (after some dilution). Due to its origin, that turbidity current had also the shape of a lens that slid downhill. (By "lens" we mean a feature having zero thickness along its rim, which is a closed contour.) For simplicity, Nof (2012) took the lens to be of infinite extent in the direction perpendicular to the cave, i.e., the top and bottom of the cave were taken to be parallel slanting planes. The turbidity current height was probably higher than the height of the Squaws Restriction so it blocked it once encountering it. The restriction effectively sliced the top of the turbidity lens off, allowing for a smaller lens to continue propagating downstream beyond the restriction.

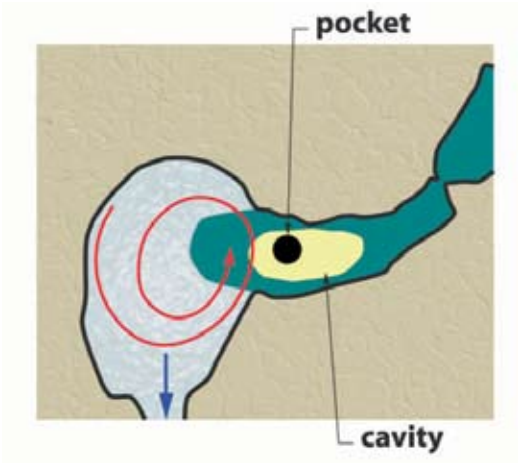

Fig 7. : A top view of the basin and cave entrance showing the pocket, initial cavity on the bottom and the surface vortex in the basin.

There was probably never a complete blockage of the restriction, which explains how Gavin managed to get out of the cave. For all practical purposes associated with cave diving, however, once the visibility went to zero (as it did in the case in question) and the guideline was nowhere to be found (because it was buried in the avalanched sediment), then the restriction was effectively blocked to the divers. Next, we shall estimate the speed of the avalanche. Consider the downhill propagation rate of a two-dimensional turbidity lens, i.e., a lens (Fig. 4) with an infinite extends in the long-slope direction situated between two parallel sloping planes representing the cave floor and ceiling. The lens migration rate can be estimated from the balance between the forward gravitational force and the backward drag on the lens.

In the ocean, where most underwater landslides have been observed and studied, the ratio of depth to length is roughly 1/100 (depth of the ocean and the length of the continental rise or continental slope) so the turbidity currents have that ratio, too. By contrast, in the cave, that ratio is expected to be more like 1/1 or 1/10. An interesting point to note here is that, although the cave is typically much longer (miles) than its height or width (say 5-50 feet), most caves consist of relatively short dynamically separated sections, which are bounded by breakdowns or other abrupt changes in their configuration. In the case in question, such a section is between the entrance and the Squaws Restriction, which is roughly 300 feet into the cave. The cave is about 30-60 feet in diameter, making the thickness/length ratio 1/5-1/10.

Using the equations given in Nof (2012) one finds a fast propagation speed of 8 feet per-second into the cave (against the usual outgoing flow from the cave, which is typically no more than two feet per second). Assuming that the restriction reduced the lens size in half, we get that upstream of the restriction (i.e., farther into the cave), the lens propagation speed against the usual current in the cave was about 6 feet per second. How far could such a lens penetrate? Assuming temporarily that the cave would not have had any breakdowns or other changes in configuration, it would have propagated until the sediment settled out of suspension.

For sand, the corresponding formula in Nof (2012) together with the adapted choices of parameters give a settlement speed of about one foot per-second whereas for clay it gives about 10^{-5} feet per-second. Silt would be in between the two. These mean that for the particles to settle out of the 15-foot-think lens would take between 25 seconds (sand) and 3 days (clay). Silt would sink in several hours. This, in turn, means that, without obstructions and with no turbulence in the water, the lens would have propagated at least 150 feet (where the sand would settle) and at the most 300 miles (where the clay would settle). Silt would have probably penetrated several miles. It is, therefore, not surprising that Gavin saw sediments 1200 feet into the cave.

As already alluded to in the introduction, the fact the sediment was observed on the bottom 700 feet into the cave does not at all mean that the entire flow within the cave reversed direction. While the turbidity current itself advances downhill on the floor, the clear water above it flows in the opposite direction (uphill). This compensates for its volume

flux so that there is no net flow downhill or uphill ahead of the turbidity current head (Fig. 4). Given that the minimum thickness above the turbidity current is roughly 60 feet, we find that the maximum uphill speed directly above the lens is roughly two feet per second.

The vortex in the basin

We shall now explain the vortex, as well as the sudden drop in water level observed by the surface support personnel. During the second stage of the collapse, when the cavity in the sloping bottom sediment had just been formed, water from somewhere else must rush in to fill the space that is now empty. This water could have come from the spring itself but, evidently, this source could not provide a large enough volume quickly enough. The basin above is another potential source and, apparently, this is where the water came from. Just like water draining in a bathroom sink, such a flow tends to spiral in because even a tiny initial orbital flow present near the periphery of the sink is dramatically magnified when the outlet is reached. This is because of the familiar conservation of angular momentum discussed in most textbooks on fluid dynamics. It states that any fluid particles that approach the center from a region away from the center have a forever-increasing orbital velocity. This created the vortex that the surface support personnel apparently saw (Fig. 7). The generation process only lasted for a short time (a few minutes at the most) until the cavity space was filled with basin water. At this point the reversed flow from the basin into the cavern ceased.

Note that the net volume of the cave (i.e., the volume of the space confined by solid media) has not changed due to the mudslide. The mud associated with the slide merely changed its position from the cavity on the floor to the mud contained in the lens-like turbidity current (Fig. 4). Consequently, while basin water was drawn into the cave to fill the cavity, other water must have been expelled out of the cave into the basin. Therefore, the basin level did not change due to this process, which formed a (temporary) asymmetrical horizontal dipole. Note that, although the expulsion involved the same amount of fluid as the inflow, it must have involved a much weaker flow (and, hence, less noticeable). This is because it was associated with a divergent flow on the surface rather than a convergent flow.

A short time after the slide (minutes), the mudslide-lens reached the restriction and blocked most of the flow coming out of the cave. Meanwhile, on the surface, the basin's outlet downstream continued to flow and this lowered the water level in the basin. Taking the surface area of the pool to be 300x300 square feet and the flow out of the cave to be 150 cubic feet persecond, we find that the basin had been lowered by two feet in just 17 minutes. While this was taking place, the hydrostatic pressure behind the restriction continued to build up within the limestone until there was enough of it to force the sediment out of the partially blocked restriction. At this point, the cave started clearing itself up so to speak.

Discussion

This is an attempt to bring two different scientific fields, forensic science and fluid dynamics, into one frame of mind. It is not obvious to us how successful we were in achieving a breakthrough but we did succeed in explaining the events that led to the collapse of the Indian Spring cave, and the drowning of Parker Turner. As in Nof and Paldor (2010), we argue that the whole process started by resonance in one of the air/gas pockets typically present in most caves visited by cave divers (Figs. 3, 4, 5 and 6). In contrast to Nof and Paldor (2010), however, we identified the pocket occupied by one of the divers decompressing in the cavern (Fig. 5). Obviously, that diver could have not possibly known about the resonance that we are alluding to.

We distinguish between four different stages of the collapse. During the first (or initial) stage, a resonance was established in the pocket, the pressure rise uncontrollably and the limestone in the immediate vicinity of the pocket broke (Fig. 4, left side). During the second stage, broken debris fell on the slope below. This caused the mud to slide, creating an initial cavity in the sloping bottom (Fig. 4, left side). In the following third (or intermediate) stage, the sediment initially contained in the cavity got diluted with fresh water and established a lens-like turbidity current. This current then rushed quickly downhill, blocking most of the restriction shortly afterwards (Fig. 4, central part). In the fourth (terminal) stage the smaller lens-like turbidity current (whose top was effectively "sliced off" by the restriction) propagated more slowly downhill (Fig. 4, right side).

Equation (2) in Nof (2012) was used to calculate the periodicity associated with the resonance. It is about 40% larger than the value calculated by Nof and Paldor (2010), which is still very relevant to the problem at hand because of the simplifications involved. The main difference between the two is due to the basin serving as one of the U-tube arms. [The periods that we present in both Nof and Paldor (2010) and here are actually the same because the identified pocket was deeper that the pockets considered in Nof and Paldor (2010).] We then used equation (3) in Nof (2012) to calculate the speed that the mudslide migrated downhill and found it to be roughly 8 feet per-second. The clear water above the mudslide moved in the opposite direction at approximately two feet per-second so there was no net flow upstream ahead of the turbidity current.

We then estimated how long such a turbidity current would last before the sediments (sand, silt, clay) settle out of it. Using this information, we then showed that it could penetrate large distances into the cave (miles, had there been no obstacles). With this scenario there was never a complete flow reversal where water rushed into the cave instead of rushing out. There was, however, a brief period (minutes) when basin water rushed into the cave to fill in the space created by the mudslide that detached from the bottom. This flow created the surface vortex observed by surface support personnel (Fig. 7). A weak current exiting the cave and carrying the same volume compensated for it

so the mudslide did not create any net flow.

In both the resonance and mudslide calculations we have ignored the pre-existing current within the cave assuming that, since our processes are linear, this flow can simply be superimposed on our calculated flows. We hope that this study will encourage further investigations involving more accurate and detailed calculations.

Acknowledgements

I am very grateful to Lamar English, George Irvine, Alexander Kaye and Bill Main for sharing their experiences with me. Cindy Butler has helped me a great deal with both my sidemount gear (well before it became popular as it is today) and my attitude. I also thank John Arthur (FGS) for his help regarding the earthquakes record. My scientific work is supported by NSF (OCE-0752225, OCE-0928271, ARC-0902835 and AGS-1032403) as well as the BSF (2006296) and FSU (through my regular academic appointment as well as my Fall 2010 sabbatical).

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OFF to tHe Side.....

By Rob Neto

There's a common misconception by many divers that all sidemount divers are cave divers and only go into small spaces. While that is one of the reasons for diving sidemount, it's not the only one. It's also not the most common reason. Many divers choose to dive sidemount because the advantages of the system appeal to them or because of health related issues. And, yes, some even do it because of the cool factor.

Sidemount was originally created as a way for cavers to get past sumps they encountered in dry caves. The first sidemount rig was very different from the rigs we currently see being commercially produced by dive equipment manufacturers. It consisted of a simple belt with a loop on each side to hold the cylinders on the body of the diver and the tanks were positioned low on the body. The main advantage of this configuration was the simplicity of it. It was easier for cave explorers to carry single tanks, rather than manifolded tanks, into caves to the sumps where they would be needed. The harness system was also small enough to be worn or carried in a small pack.

As cave diving in the UK progressed, it was also experiencing its beginnings in the United States. Florida, well known for its thousands of fresh water springs, was the center of cave diving activity. Prior to sidemount, quite a bit of cave exploration had taken place in many of the known springs. but the passages were mainly large and being negotiated by divers wearing backmounted double tanks. This left miles of passage unexplored. Some divers began experimenting with the harness systems being used in the UK. The need for an air cell for buoyancy control was more of a factor in the Florida systems, so divers began modifying jacket BCs for sidemount configurations.

Rather than bore you with more history of sidemount, we'll fast forward to today. In the early 2000s, the first couple of commercially available sidemount systems were produced and placed on the market – the Dive Rite Nomad and the Golem Gear Armadillo. While they shared many similar features, they also differed from each other in many ways, namely in the harness and the lift capacity of the wing. Today, we have over half a dozen commercially produced sidemount systems available to divers. Some of these systems are suited to cave diving, some are better suited to open water diving, and some are marketed for both cave divers and open water divers. While there are many divers who dive these systems unchanged out of the box, many also make modifications to suit their diving to these systems (more on modicifications in a later article).

Sidemount systems continue to evolve as more and more divers experiment with it. Unlike traditional backmount systems, there will likely not ever be a standard sidemount configuration. While most divers begin diving manifolded backmounted double tanks for a specific purpose, such as technical diving, as stated earlier, divers begin sidemount diving for different purposes. As long as this holds true, a standard rig will not develop.

One of the original reasons divers started diving sidemount was to get into smaller passages. not passable with backmounted cylinders. While the passage may be pretty wide, the floor to ceiling height doesn't allow passage of a backmounted diver. There are several passages located in the caves of North Florida that are only passable by lower profile sidemount divers as well as several passages and caves that have significant size passages, but the opening to them is only large enough for a low profile sidemount diver. While backmounted divers have tried to pass through these openings, many fail, and the damage they are causing to the system is very evident. In this case, sidemount is using the right tool for the dive.

Some people dive sidemount for health related reasons. Whether it's a bad back or bad knees, removing 100

pounds of steel from your back can be an orthopedic miracle! Dissenters will argue that this requires more trips to the water and sidemount divers still need to carry tanks, but that's not necessarily the case; with a $40 truck cart from your local hardware store the tanks are easily rolled to the water from your vehicle in one trip. Once in the water, the tanks are much lighter and easier to handle. They are also less stress on the diver's back, since moving the tanks to the side gets the weight mass off the spine. Moving the tanks down also allows a different body position in the water. While many backmount divers must arch their backs significantly to maintain a horizontal position in the water, this isn't the case in sidemount.

Finally, there's the cool factor. I'm not going to elaborate on this type of sidemount diver since they are pretty easy to pick out. Fortunately, at least in my experience, there aren't too many of these.

> "While backmounted divers have tried to pass through these openings, many fail, and the damage they are causing to the system is very evident. In this case, sidemount is using the right tool for the dive."

Cave Diving Milestones

By Shirley Kasser

It's that time of year again! This year's cave diving milestone awards were announced at the annual workshop. Those present received a certificate, marking this exciting high point in their cave diving career. The remaining recipients will receive their certificates by mail.

Two divers reached the 500 mark, earning their Henry Nicholson Award: Robert Beckner and Keith Gault. Congratulations, gentlemen!

Thirty-seven divers qualified in the last year for the Abe Davis Award by reaching their 100th cave dive safely: Sheila Allen, Jonathan Bernot, Marcie Bilinkski, Jim Bondurant, Bob Bost, Jeff Chance, Michael Clay, Brent Cooper, Andrew Dennis, Marci Edwards, Johnathon M. Fulop, Brian E. Hamilton, Jeffrey E. Hawes, Joseph Karl Haywood, Christa Howarth, Alicia Lamborn, Marissa Lasso, James Little, Zane L. Marshall, John A. Marut, Dagmar Moeller, Nancy Murray, Kristine Rae Olmsted, James Ryan Parkevich, Todd Polson, William J. Ripley, Brian Ross, Alicia Schryver, Brian Sheridan, Terri Simpson, Don Six, Chris Smith, J. Hunter Sutton, M.D., Garret Toomey, Glenn R. Van Vliet, Larry Vrooman, and James Wetzel. Congratulations to you all!

Marci Edwards was one of those thirty-seven. She shares her cave diving romance with this beautiful story of her 100th dive and the path she took to get there:

My 100th cave dive after passing Full Cave was a normal, average dive. My buddy Larry Vrooman and I went down P1 and surfaced in Olsen by way of the Olsen Bypass. It was a 53 minute dive on May 31, 2011 - fun, but unremarkable (thank goodness).

The way I got to that point is a bit more interesting. How did a pudgy, nonathletic almost-40 year old become a passionate cave diver?

It started on my post-open-water dive number 2, in February 2005. I had made some diving friends online. (In passing, I'd like to point out that I've only been on 2 dives with someone I *didn't* first meet through online contacts. The internet is a wonderful way to find buddies!) Those friends were a group from North Carolina who invited me along on a trip to Ginnie Springs to stay with them in the cottage and dive the springs. The mix of skills in the group was vast - me, freshly out of open water, three guys who were taking cavern, a couple of people at open water level but more experienced, and Bobby Franklin, who was full cave. On my open water dive number 2, Bobby took another open water diver and me to the Devil's side (we were without lights, of course.) We went down in Little Devil, hereafter known as the Devil's Crack. We went down the run and into the open area of the Eye. We went out in the river to the Ear. Bobby went in and turned around while we were out in the open, and we couldn't see him, but we sure could feel the flow.

He was so effortless and solid in the water, and I looked at him and thought, "I want those skills. I want to look like that. I want to see where he went in that dark." So I aimed my sights at cave diving from that point. Both Bobby and Jason Bone were excellent mentors, and I did a lot of quarry diving working on cave skills with their help.

Dive 100, one year later, was back in Florida taking Cavern and Intro. It was wonderful! The Peanut Tunnel was how I had envisioned cave diving to be, so I was surprised at the different passage sizes and floors and walls, even in Peacock. Dive 188, two years after that (time off to have a baby), was my first cave dive with my current buddy, Larry. How lucky to meet a compatible guy who was also Intro and an excellent buddy! Dive 206 four years after Open Water was Apprentice/Full class with Larry. Almost all my dives since have been with him.

I love diving caves. I love the focus, concentration, and pursuit of perfection that come beforehand so that the actual dives are calm and my mind can roam a bit. I love the formations in the caves I've seen, whether Florida or Mexico. I love the thought that goes into even small decisions. I love the friends I've made. And I love my dive buddy.

Brian Garby topped off a great cave diving vacation with number 100 with a great friend and road trip buddy. His narration, complete with mystery and a happy ending, definitely sets the cave diving siren to calling. Enjoy Brian's trip in his own words:

Shakin' Hands with Abe Davis

The August dawn broke hot and steamy as my dive buddy Capt. Steve Thacker and I guzzled our morning coffee at the High Springs Country Inn. Sunday August 22nd would be my 100th cave dive after completing Full Cave with Jim Wyatt in December of 2007. Subsequent courses in Stage and DPV had hopefully prepared me for today's Abe Davis qualifier.

Celebrating his Abe Davis
Photographer: Steve Thacker

As it turned out, this would be the last dive of a f ive-day, ninedive, 1000+ mile trip with Steve, 3 scooters, and too many tanks to count, all hauled along in CDAVE (Cave Diving Assault Vehicle), Steve's trusty F250 van, stripped out for diving gear – with the exception of a killer stereo. The trip started with a mellow cave diving tour of Merritt's Mill Pond. We stayed in the trailer next to Cave Adventurers and quickly fell into a rhythm of laid-back diving from one of Edd's pontoon boats. Steve (as owner of a dive shop never lacking for equipment) had the foresight to bring along his Honda generator so we could top off our UV18's during surface intervals. DPV assisted tours of Jackson Blue and Twin Cave afforded us a "lazy-man's" access to areas of the caves without beating ourselves up in the flow, something that gomers of our ages appreciate! Don't worry, we swam the same dives on previous trips and knew we could exit safely even if both scooters failed. Evenings were

spent in contemplation of the day's dives and review of Steve's pictures – really professional quality. I had the easy job posing and only had to remember to hold my breath at picture time.

After a morning dive at Hole In The Wall to photograph the subspecies of blind salamander found only in this cave, we schlepped our gear back into CDAVE and headed for Madison Blue. Getting back to our roots, we did two easy swim dives up the goldline, devoting the second dive to pictures at the Half-Hitch restriction and the breakdown at approximately 300' p.

Having spent the night at the Country Inn, we thought it fitting that at least one of our dives should be at Abe's old stomping ground, Little River. We had a leisurely dive up the Serpentine Tunnel to the end of the Florida Room, called the dive on thirds and shot some photos in the cavern zone. After chatting with "Two R" Forrest Wilson, we headed over to Ginnie for the Abe Davis qualifying dive. Aided and abetted by lots of UF eye candy (this Sunday was the last before the start of the Fall semester), we scootered down the run from Little Devils and made the ear-squeaking entrance into the Ear with scooters on 9. Having previously arranged to share primary lines with friends, we dropped our 02 at the sign and scootered up the gold line with props set on 7. We enjoyed the up and downs of the main tunnel, but called the dive at 1900'p. due to a combination of poor vis. from river intrusion and my recurrent ear-clearing issues. Exiting the Eye, we battled our way down the run through the bikini-clad hordes (nobody ever said cave diving wasn't fun!) to Little Devils and CDAVE. As we unsuited and prepared to enjoy a postdive beverage, a disturbing note on the van's windshield provoked an anxious moment – "We found your wallet in the bathroom". Fortunately for Steve, two honest young men found his wallet stuffed with cash sitting on the bench and returned it to him intact, earning themselves $20 in beer money and our profuse "Thanks" – will wonders never cease.

Entering Twin
Photographer: Steve Thacker

Scootering the Mill Pond
Photographer: Steve Thacker

Enjoying a celebratory cigar (doc said one was OK) and a beer, Steve and I reflected on a great trip to six different caves, my 100th cave dive, and memories to last a lifetime. Glad to meet ya' Abe!

Thank you both for taking the time to share your stories, and thank you for being a great example for our sport.

What's your story? Email your milestone stories and photographs to me at abedavis@nsscds.org or snail mail them to me at 1228 Gina Court, Apopka, FL 32703.

The Loop

By Joe Citelli and Gene Hobbs

Rooster Cogburn, Rebreather Diving and True Grit

This quarter's column is the result of a discussion with my good friend Gene Hobbs of the Rubicon Research Repository. Gene attended the recent Rebreather Forum in Orlando, Florida and I have co-written this column with him. I would like to thank him for his efforts and input.

Do rebreather divers have grit? Grit is defined as perseverance and passion for long-term goals and ties in with positive psychology, in particular, with perseverance or the ability to stick with and pursue a goal over a long period of time[1].

So, you might ask, "What does this have to do with Rooster Cogburn and successfully diving a rebreather in a cave?" Well, for those of you who don't know, Rooster Cogburn was the character portrayed by John Wayne and later by Jeff Bridges in the movie True Grit. Rooster was an old, washed up but persistent drunken marshall who succeeds when no one other than a small child believes he has "true grit".

At the recent Rebreather Forum 3.0 (RF3) conference held in Orlando, Dr. "Bill" Stone of Stone Aerospace (and Wakulla fame) gave a presentation on "Hazard Analysis and Human Factors." In it he discussed automation and failures in the design of life support equipment. Since a major factor in the design and operation of a rebreather is the diver, at the end of his presentation he posed a question to the room inquiring about the psychology of rebreather divers. Referring to an earlier presentation by David Concannon which showed that during investigations conducted subsequent to rebreather diver fatalities over the last eight years (maybe half the total), no checklist has ever been recovered with the diver's personal effects. He made the point that if divers are taught by the training agencies and encouraged by the manufacturers to follow a checklist, why don't they do it and is there a way to know who will or will not maintain this practice after training?

In 2007, researchers at DAN reviewed the common causes of rebreather fatalities from 80 incidents which occurred from 1998 to 2006 in the United States and Canada.[2] In only 30 of these cases was there enough information available for a trigger of the accident to be identified. In three of these cases, the triggering event was actually the rebreather (display flood, oxygen supply failure, and an unspecified malfunction). With the exception of the unknown malfunction, we are all trained to deal with the problems described in the report.

In 1995, Dr. Acott had 55 recreational divers do a pre-dive check of open circuit equipment as they would normally evaluate prior to diving.[3] Only two of these individuals detected all of the faults presented to them. This leads one to wonder what will begin to happen as more divers move to rebreathers. Will the same complacency that exists in open circuit diving continue to creep into rebreather diving? Why have we not seen more of this already?

Many fields have long had an interest in identifying attributes that predict success. By identifying those individuals that will succeed without the need for immediate positive feedback, you can identify people that will be successful despite failures or adversity they experience. The trait present in these highly motivated people was defined by Dr. Duckworth as Grit. Gritty people have a "perseverance and passion for long-term goals."[4] The measure of Grit has been shown to correlate with success with West Point military cadets and Scripps National Spelling Bee finalists.[4]

Grit is measured by a questionnaire that ranges from 88 questions in the full version to as little as eight in shorter revisions. If we know which individuals in our community lack the intrinsic motivation needed to ensure their safety in the long term, perhaps we can begin to promote a culture change that is needed to achieve better safety.

Looking around the room at Rebreather Forum 3 and at the Diving Equipment Manufacturers Association (DEMA) meeting last year reminded me that I am seeing the same friends at many of these meetings. Exploration is conducted by many of those same people. What is it about these people that makes them stick with it and push themselves? Many of them have moved beyond the use of open circuit scuba and into rebreathers. Do they do it because they have grit?

Intrinsic motivation,(grit), is also an individual's ability to be motivated without an immediate reward. Participation in the activity coupled with the expectation of future success is reward enough, even if that success comes far down the road. Hence, the individual is "intrinsically motivated." So, you might wonder, "What does this have to do with rebreathers?" The answer is that a form of success in diving rebreathers might be defined as long term survival and that

survival appears to be directly related to the individual's degree of "perseverance and passion." That is the same perseverance and passion that the successful explorer has when he explores the same tunnel for years looking for new leads without ever losing hope or getting discouraged.

The fact that over the last eight years fatal accident post mortem investigations show that "no checklist has ever been recovered with the diver's personal effects" supports the notion that divers who are intrinsically motivated fare better than those who are not, and that those who do not possess this trait are more likely to have a fatal event. The checklist in and of itself is not the key factor, but rather that the diver is motivated enough to use one. Checklists can come in many varieties, my own preference being a specific ritual I use when preparing for a dive. This ritual is supported by a printed list but the list is referred to after the fact and not before. My logic for this is that it subtly forces one to commit the list to memory and prevents scanning a list by rote without thought. This may or may not work for others.

The best way to achieve this is to follow a logical sequence when doing your prep and NEVER deviate from that sequence or ritual. Also, NEVER allow yourself to be distracted when preparing for a dive. When people speak to you, politely tell them you cannot be distracted from what you are doing and then restart your preparations from the beginning. But I digress….

Rooster Cogburns' success can be found in his single minded determination and his refusal to accept failure. This is "True Grit" and it is a highly desirable trait for a rebreather diver (or any diver for that matter) to possess. It is what motivates the lost or trapped diver to never lose hope and quit. Those who possess it believe in themselves. For them, failure is never an acceptable outcome so they naturally and instinctively have the power of a positive mental attitude working for them. That personality trait is what allows them to enjoy a higher success rate than those without it.

So how do we identify those with "grit" and, more importantly, how do we identify the adrenaline junkies: divers whose nature is such that their need for instant gratification will override their abilities and training and will push themselves to continue on until they fail, which in the case of rebreather diving, is often called a "fatality".

There is no easy answer. However there are ways to increase intrinsic motivation[2]:

* Give the tools needed for success.
* Give rewards based on performance.
* Use verbal and non-verbal praise.
* Vary the content and sequence of practise drills.
* Involve the participants in decisions.
* Set realistic performance goals.

Complementing this is "flow". "Flow is a certain kind of intrinsic motivation that someone can feel. It occurs when someone feels an overall, intrinsically motivated feeling when they are totally involved in an activity and are on 'auto pilot.'"[5] It is when everything works right and you know you will be successful. The thought of failure never crosses your mind, not because you are over confident, but because you have grit.

So, what is the solution to the problem "elephant in the room?" We can screen and test. We can require people jump through various hoops and barriers. But, ultimately, it is up to the individual to self analyze, screen and test him or herself. Only you as an individual, and, maybe one special little girl, can tell if you have "True Grit."

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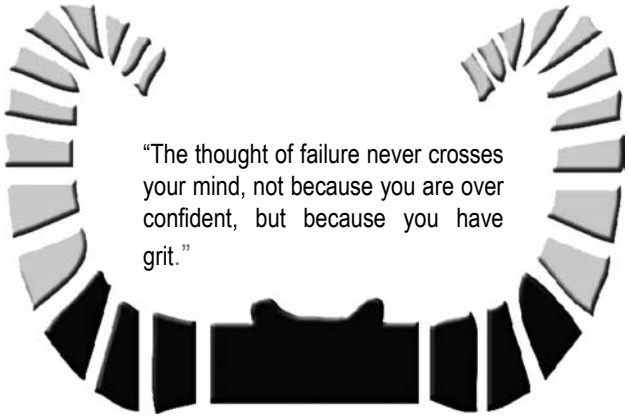


2012
Midwest Workshop

Saturday
September 15, 2012

St. Louis, MO

Speakers

Duane Johnson
Gene Melton
Michael Angelo Gagliardi
Rob Neto

nsscds.org for more details

Photographer: Brent Cooper

Visit With A Cave:

Downstream Cow. Photographer: Paul Heinerth

Off the dirt lane roads of Luraville, Florida you will find one of the treasures of the NSS-CDS; Cow Spring. Owned and managed by the NSS-CDS, access to the spring is limited to NSS-CDS Members and outlined on their website www.nsscds.org under managed dive sites.

Begin at the Dive Outpost, where you will check in, sign a waiver, and exchange your certification card for a key. A short drive to the site and throughthe cos pasture gate (be sure to lock it behind you), there is a picnic table, sign with GPS coordinates and directions for emergency planning and port-a-john for convenience.

The spring is able to accommodate all levels of diver with a small spring basin, cavern and up and downstream passages. Both are sidemount dives due to the size and conservation needs of the cave.

While walking tanks down the narrow path to the water, watch out for poison ivy and step carefully. Once at the water, you will find a nice limestone ledge to gear up from in the water. At the north west end of the basin begins the cavern, with entrances to Downstream Cow to the left and Upstream Cow to the right.

Clay Bank. Photographer: Riana Treanor

Downstream Cow is a short, shallow, fairly wide cave that slowly narrows to some low silty passage.

Upstream Cow begins with a nice twisty and tight entrance. If you do not like small tight spaces this is not the place for you. Once down the entrance about twenty feet or so, you can tie in

Cow Spring

By: Riana Treanor

to the gold line and continue on in the passage.

As you continue, you will come across the “ski rope”; while this rope travels the same passage as the goldline, it does not always follow it exactly. When the aquifer is charged, the flow is very strong and the ski rope was installed so divers could pull themselves along without damaging the cave.

Upstream restriction. Photographer: Riana Treanor

Continuing on will take you past some beautiful clay banks. In 2008, a diver carved his initials in to one of the larger banks and was later found and prosecuted. With the cooperation and help of several dedicated and artistic divers and several local dive shops, in 2009, that damage was repaired.

The ski rope will eventually join once again with the goldline and end. As you continue, the line will make a sharp turn downward through No Fault, a small opening leading to lower areas. At the end of the line, who knows what you could find: maybe the namesake of the system?

Traveling through this cave you will encounter small low passages, restrictions, fissures and delicate areas of rock and clay bank formations. Buoyancy and profile is of the most importance and if you are not proficient, comfortable or experienced with tight passages, this may not be the dive for you. Our conservation of this cave as well as others, preserves their beauty and diving experience for both our current and future divers.

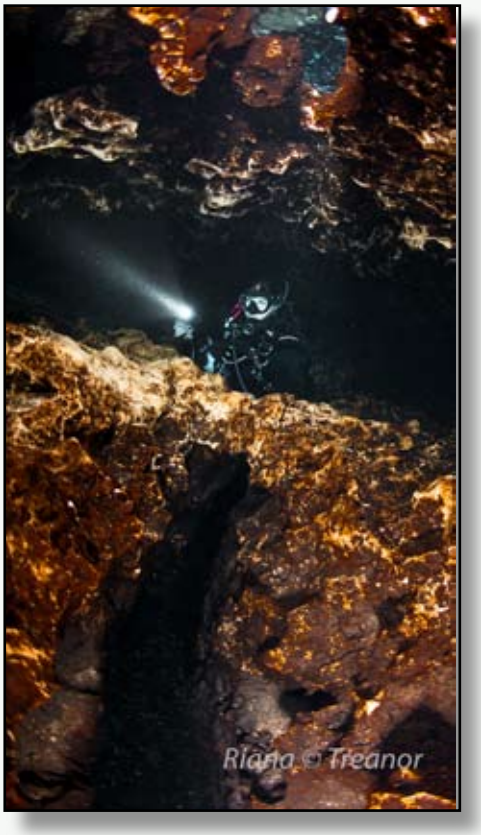
Look but don’t touch.

Along the ski rope. Photographer: Paul Heinerth

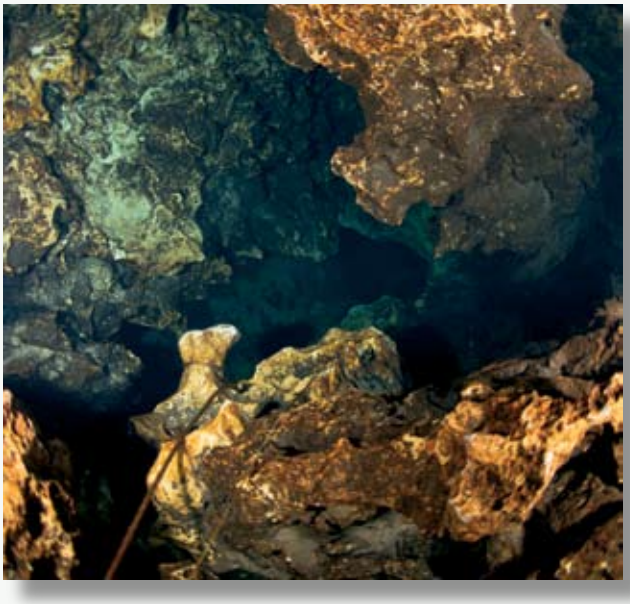
Upstream Cow. Photographer: Paul Heinerth

Downstream Cow. Photographer: Paul Heinerth

Upstream Cow. Photographer: Riana Treanor

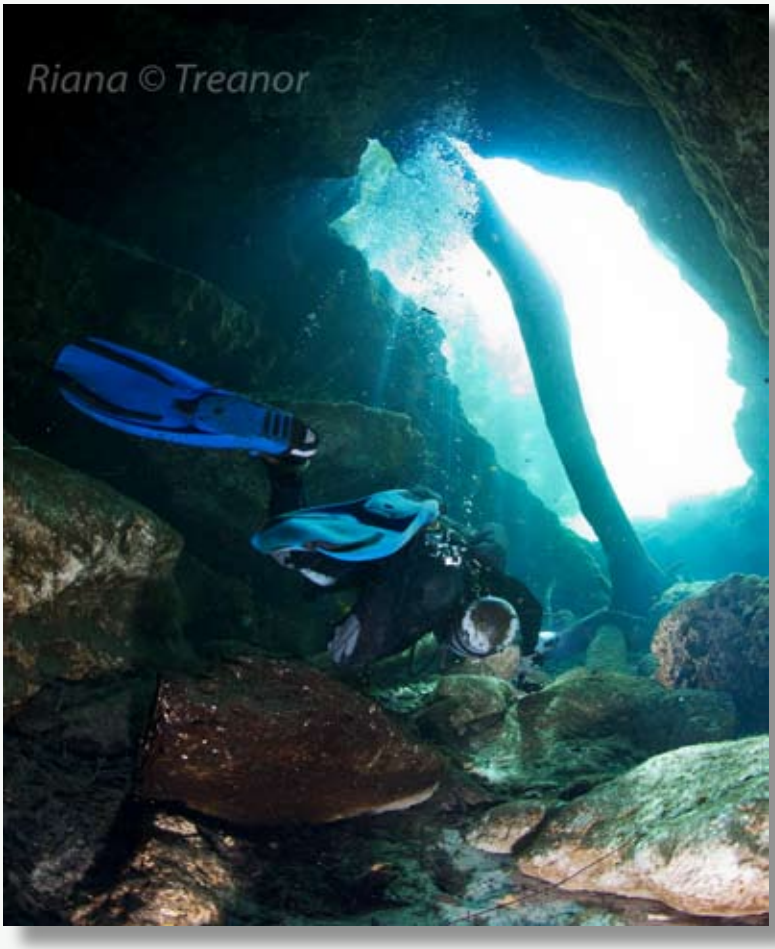


Upstream fissure. Photographer: Riana Treanor



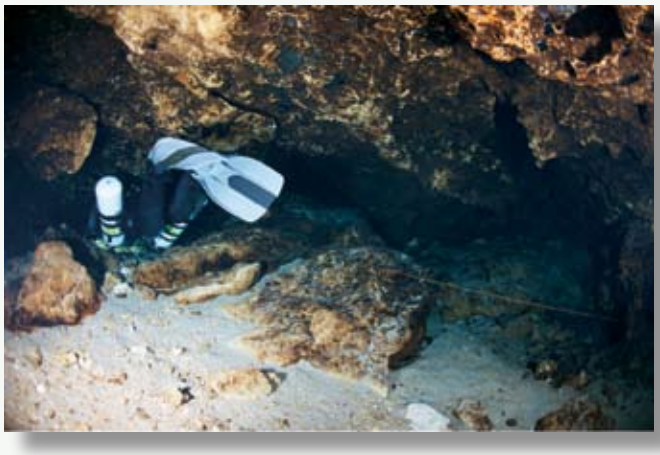
Sights you will see and passages you will take while traveling Upstream Cow

Photographer: Riana Treanor



Diver just "humming along" in the cavern at Cow Springs

Photographer: Riana Treanor



Going in..... and almost there..... two of the passages in Upstream Cow.

Photographer: Riana Treanor

Skills, Tips & Techniques

By Jim Wyatt

Photo: Gene Page

Mixed Team Diving: Open Circuit And Closed Circuit Rebreathers How Do We Manage?

We are seeing lots of closed circuit rebreather (CCR) divers at the dive sites these days. There have been days when all I saw were CCR divers. We are of course still seeing lots of open circuit (OC) divers at the dive sites. And we are also seeing these divers dive together in teams.

This article is going to suggest one way for these teams to dive together safely in terms of dealing with loss of gas for either the OC or the CCR diver.

There are several approaches to this issue that I have seen and have had explained to me. This will explain to you the one that makes the most sense to me. I encourage you to seek other strategies that may work for you and your mixed team.

Obviously, the goal is to make sure that both divers have sufficient gas for an exit due to a catastrophic gas failure at maximum penetration. That is easy to say, but not always so easy to calculate. If a CCR diver bails out to OC due to excess CO2 his/her breathing rate will skyrocket and require twice or more the volume as s/he would during a normal exit.

The "fear factor" may cause greatly increased breathing rates in both divers dealing with an OOA situation.The point here is that carrying enough gas for a "normal' exit, under normal circumstances may well leave the team short of the exit.

What follows is one procedure I think we can successfully use to ensure the team has enough gas too exit.

The CCR diver should carry two separate OC bailout tanks and the OC diver should carry one "buddy bottle". Volume requirements will of course depend upon depth and penetration distance. If the team is in a shallow cave and staying near the entrance their volume requirements are clearly less than the team diving deep and planning a long penetration. Determining these volume requirements is another issue…

The CCR diver should have both bailout bottles configured so s/he can breathe from them and have one of those configured with a long hose for his OC buddy to use.

My CCR setup employs an OC regulator off of my left side bailout bottle on a necklace so that I may pick it up quickly and breathe from it. That bottle's valve remains in the fully "on" position for the entire duration of the dive. I have another bailout bottle on my right side with a long hose. This right side bottle's valve also stays fully "on" throughout the dive and is attached to the bottle in such a manner that my OC buddy can grab and deploy it all on his/her own.

The OC divers' buddy bottle can be of standard "buddy bottle" configuration, in that no long hose is needed. If the CCR diver has already bailed out and is about to use up his/her second bailout bottle the OC diver will then pass his/her buddy bottle to the CCR diver. Of course the OC diver should be able offer his/her long hose if they see the CCR diver bailing out to OC.

CCR Cave divers are taught bottle passing in the CCR cave class. OC cave divers are taught bottle management in their OC stage diver classes; so passing the bottle should present no undue challenges.

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Midwest Underground

WARMING UP IN COLD WATER

By: Chris Hill

Warning: The use of the heating system contained in this article is at your own risk.The use of heated undergarments such as described in this article can result in serious burns or minor electrical shock.Neither the OCDA, Author or NSS-CDS is responsible for any resultant misfortune the that may result from the information contained in this article.

Diving in the Midwest can certainly be a chilly experience, and one way to mitigate the cold is with heated undergarments. This article will give one example of how to provide yourself with a little extra heat in the cold water. Generally, during short duration dives, you can employ adequate thermal undergarments to stay warm; however, for a longer bottom time followed by a lengthy deco obligation, you stand a good chance of getting pretty cold (which also doesn't foster an efficient deco process). If you add in using scooters and breathing trimix, the cold factor increases. During deco stops is when auxiliary heat is most commonly used, although it can be used throughout a dive if desired.

Gerbing heated vest. I've installed a grommet to route the wiring through the vest rather than hanging out the bottom. Large lead acid battery pack with Marshall cable installed. Photo by Chris Hill

So how do we effectively and safely add heat? Chemical heat packs are not generally a good idea, as they can break causing chemical burns, plus there is no way to regulate the heat. *Note: Chemical heat packs of the type that require oxygen to function will not work with argon and will cause severe burns when used with air as the drysuit inflation gas due to the elevated PPO_2(thermal runaway).* Electric garments that use a battery housed inside the dry suit are also frowned upon since the heat can't be controlled. That leaves us with using a heated undergarment with an electric source external to the dry suit that can be turned on or off as needed. So let's explore one variation of setting up such a system.

Four key components are needed: an undergarment wired for heat, a fitting that allows an electric connection through the dry suit, a power source, and cabling to connect the power to the suit. If you dive on a team or with a group of friends, it's a good idea to standardize on the electric connection types so sharing of equipment is possible. Much of the information presented in this article was compiled from members of the Ozarks Cave Diving Alliance (OCDA) in Missouri (who gathered it from other sources) and thus has been used successfully on major exploration dives, as well as recreational dives in frigid waters such as the Great Lakes.

For the undergarment, we (the OCDA) first started by making our own involving a tedious process of sewing heating wire into a garment. This is still available, but it's much easier and probably more reliable to purchase an undergarment already built with heating in mind, such as a heated motorcycle vest. The key specification is that it should be designed for a 12 volt power source. Utilizing a vest style garment will prevent binding up under the arms. Gerbing is one manufacturer that we've had success with (www.gerbing.com – PowerSports Gear section). Golem Gear also makes vests and other parts, but is a little more expensive.

For the dry suit fitting, we use one from Marshall Underwater Industries (515-549-3570). This is an underwater pluggable fitting (P/N - 26-5FBRA-4/HYP) that can be installed in the dry suit similar to how a P-valve is installed – you just have to get the nerve up to punch a clean hole in your suit. If you're not familiar with underwater pluggable connectors (or wet connectors), they're connectors that allow you to connect and disconnect electric components underwater.

Marshall dry suit fitting installed with dummy plug in place for protection. Note location of fitting on dry suit – below rib cage. Installed angling down for ease of attaching battery cable with gloves on. Photo by Chris Hill

Just about any typical dive light canister with a 12 volt battery will suffice as a power source. Obviously, larger capacity batteries allow you to use the heat longer, but the type of battery (SLA, NiMh, LiPo) doesn't matter. Typically, this is a good use for older technology batteries/canisters, which are usually cheaper to purchase. A large lead acid battery

system is good for heating during deco due to the added weight, which allows you to also add more gas to your suit for added insulation and warmth. A smaller lightweight battery setup is good if you intend to carry it with you during the dive.

View of Marshall dry suit fitting inside dry suit. Silicone buildup placed around wires for strength, but still flexible. Connector installed which mates with vest (wires soldered and strengthened with shrink wrap). Photo by Chris Hill

The last item needed is cabling with a male wet connector to mate with the dry suit fitting (Marshall P/N - 26-5MC62-1X1M). This cable will replace the existing canister cable so you'll need to request a gauge of 16/2 or 18/2 to match the diameter of the existing cord (the existing cable probably has the gauge size written on it). It's important not to get a smaller diameter cable; else leaks at the gland nut can occur. There are other wet connector cables on the market, but we've found these from Marshall to be very sturdy and withstand a beating. Also, they don't come loose under heavy use – it requires a good hardy tug to get them loose. As a side note, you can change out the cord on your light head(s) with the female Marshall wet connector cable (P/N -26-5FC62-1X1M), then everything is interchangeable. This is a nice feature in that you can use your light as usual, then at deco you can disconnect the light head and plug the battery into your suit for a little heat up. Ahh… warmth! Although, it's probably best to use a separate battery and still be able to give light signals to your buddy.

Installation is pretty straightforward: Install the Marshall dry suit fitting in the suit in a location that won't push into your ribs when squeezing through a tight restriction. Straight below the sternum and to the left a little and below the rib cage is a good location. On the back side of the fitting (inside the dry suit) build up a good amount of silicone around the wires to brace themfrom bending too far and potentially shorting out over time.You'll need to install a connector type on the back side of the fitting that will mate with the connector on the heated vest, being sure to solder the wires and use shrink tubing for a solid installation. Make sure this connector pairing will stay secure while donning the suit and during the dive. There's nothing worse than getting to your deco stop, flipping on that battery expecting warmth and getting nothing! I've seen more than one grumpy diver exit the water in a very cold state from this problem.

Heater wires under shoulder straps can sometimes get damaged. This caused a bit of a hot spot! Photo (and burned shoulder) Photo by Bob Koch.

Finally, replace the existing cord on the battery canister with the Marshall cord. Test the canister for leaks by soaking overnight in a tub of water. If all is good there, then take it to depth on a test dive, again looking for leaks. Put some tissue paper in the can to see evidence of water intrusion. If you don't feel comfortable making this modification, seek the help of the canister manufacturer or local gear technician who's familiar with your brand of canister. Turn the battery off when not in use to prevent arcing between contact points and corrosion damage (marking the switch helps here).

To protect the wet connector end(s) when not in use and prevent any damage to them purchase some dummy plugs (Marshall P/Ns: 26-5FDP - female dummy plug; 26-5MDP - male dummy plug). It's a good idea to burn test your battery with the vest just like you would with a light head. This tells you the batteries are good and how long you can expect heat to last. Another item to watch for is too much bending of wires in the vest or pressure points, such as the shoulders. This can lead to shorts in the wiring, which can deliver a surprising shock or nasty burns (which is always fun for your dive buddy to watch!). The good thing is you can simply turn off the battery. It is recommended that a shirt be worn under the vest to prevent overheating the skin. If you have a leak in your suit, your heater will generally still work fine, but use caution when turning it on for the first moment. For serious suit floods, it may be best to forgo the heater, but you can always give it a try (again, more potential entertainment for your buddy). After donning the suit and prior to the dive, you may want to connect the battery to insure all connections are solid and the heater is working – nothing worse than expecting warmth that never comes – somehow that always makes you colder than you would have been.

Marshall dry suit fitting on left. Marshall male wet connector on right. Photo by Bob Koch.

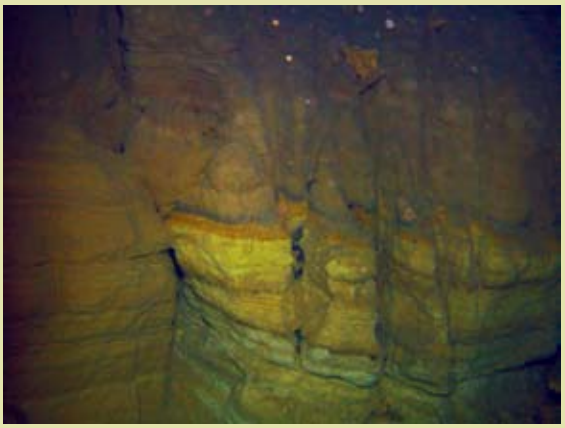
Sometimes the devil is in the details on these types of projects; email questions to: Chill99@msn.com.

Have a happy, warm dive!!

Conservation Corner

By: Kelly Jessop

Photos: Bonnie Stine



Clay Banks

Cave diving often reminds me of reading a good book. Sometimes it is impossible to put that book down because you are anticipating what will happen next, because you know the plot will take a twist. How many times have we been traversing a long small passage, kind of like the Peanut Tunnel at Peacock, only to be mesmerized by a large room that opens up in front of us? Clay banks remind me of this because they are colorful oase in the cave desert, when you least expect it.

We commonly refer to them as clay banks, but more appropriately they are stratified clay layers. The first question is, how did they get there? Unfortunately, the mechanism of formation is not clearly understood. What is known, without a complete degree a certainty, is that the colorful layers come from different oxidative states.

From a conservation position we need to admire it from a distance, because it is composed of soft clay, and any incidental contact will show marks or smears that will destroy the distinct stratified layers. When the clay bank at Cow Spring was vandalized, the CDS was very fortunate that Michael Angelo Gagliardi was able to use his talent as an artist to repair it, but this is the exception, not the rule.

As always, ”Take nothing but pictures,leave nothing but bubbles, and kill nothing but time.”

This year a worthy cause, The Great Suwannee River Cleanup, is moving to the tributaries as well. So there will be a clean up effort on the Santa Fe River this fall. Please stay tuned to the different forums to see when this is scheduled, because your help makes this successful, and promotes good landowner relations. Hope to see you there!

Beneath the Sea

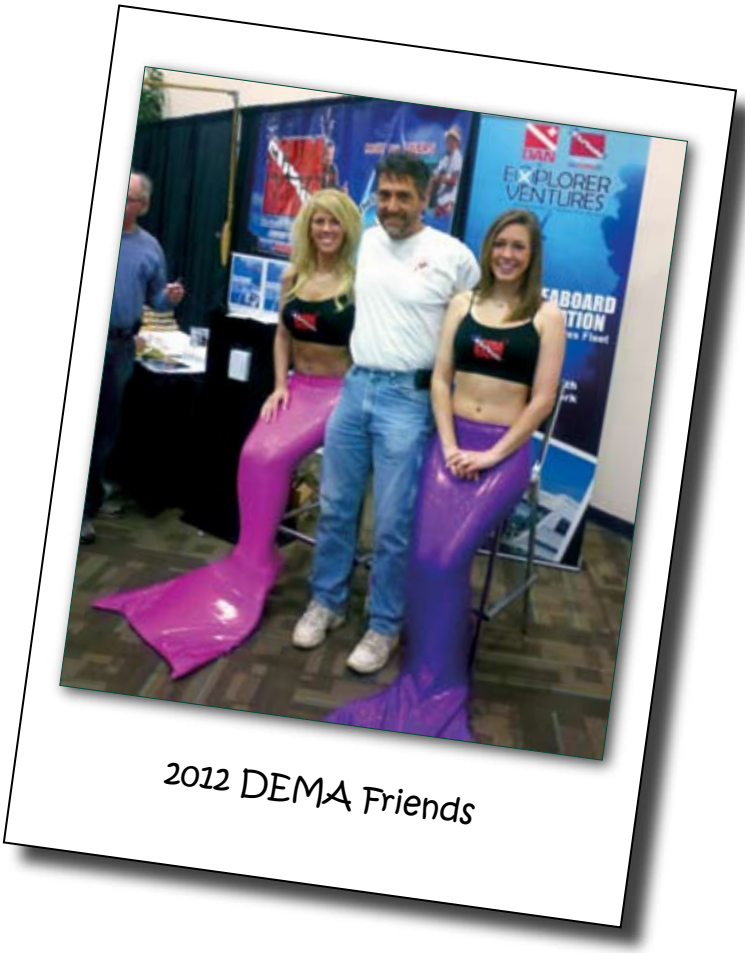
by Rob neto

This was our first time attending Beneath the Sea so please keep this in mind as you read my review. We've considered going to the show before but it never fit into our schedule. If I recall correctly, past shows had one entry fee for the show regardless of how many days and what events attendees went to. This year entry fees were broken down. There were daily entry fees or package deals, depending on how much time you wanted to spend at the show. This was a nice option for those that can't make it all three days for whatever reason.

There was a great turnout for the show. Aisles were standing room only. In fact, it was very difficult to get to some booths or to even make it down some aisles. While it's great there were so many attendees, the organizers should consider renting more space in the future. Wider aisles would have been much nicer and safer. I would hope they didn't reach their maximum capacity, but had there been a need for a quick exit it would have been very difficult to do.

There were a few manufacturer, distributor, and dive shop booths. Some of the deals available were pretty good, others not so great. Keep in mind this is coming from an instructor who is used to seeing better deals at shows like DEMA. For the general diving attendee, these deals seemed to be pretty good. The dive shop exhibits appeared to be pretty busy making sales. Manufacturers and distributors were not selling anything in order to keep from competing with the shops.

There were lots of destination/travel exhibits throughout. It looked like at least 2/3 of the exhibits were based on travel. A little higher percentage than seen at DEMA, but given the attendee base that makes sense. The displays were not as extravagant as those at DEMA, but that could be due to the smaller exhibit size and smaller venue.



2012 DEMA Friends

The odd exhibit we saw was an investment broker that looked like he had been trying to sell retirement packages. I'm not sure what he was thinking when he booked the show but he was never at his booth when we walked by it so he may have decided to cut his losses early and cut out of there. I don't know what would make someone think recreational divers at a recreational dive show would be thinking about retirement investments. LOL!

Overall, it was a good show. We got to see many friends and do some catching up and even met some new friends. We headed out to Cheeseburger in Paradise for lunch with a friend, which was a nice option over eating food provided at the show, and only a 5 minute walk from the Exposition Center. We look forward to returning next year and checking out some of the seminars.

2012 NSS-CDS Workshop

By: Shirley Kasser

Photos: Gloria Euroza Vazquez

It's that time of year again! The weekend started off with a bang at the annual pre-workshop social hosted by Dive Outpost. Cave divers were streaming in from all over, lining the roadway with dive vehicles of every description. Cathy and crew were laying out some delicious grub, while the band was laying down some rockin' tunes. Xenia and Bob were getting folks signed up, handing out t-shirts, and in general just making the registration process a breeze.

Saturday dawned early, and the party moved to Suwannee High School in Live Oak. Attendees were greeted by NSS-CDS Event signs, directing us right into the center of cave diving goodness. It was difficult to move more than a few steps at time while catching up with the many friends, old and new, on site. Bobby has obviously unlocked the secret of human cloning, as he and his team seemed to be everywhere at once.

Vendors were set up in the gym, alongside the Wes Skiles Memorial Art Exhibit. The artwork was beautiful and the dive gear distracting. It was difficult to pull ourselves away when the clock signaled it was time to move to the auditorium, but the list of speakers was an unbeatable magnet.

As folks migrated in, our excellent emcee, Cheryl, got things rolling with some prize give aways, which continued throughout the day. The sponsors really stepped up this year and provided some excellent loot.

Our first speaker of the day, Rob Neto, provided some sobering information regarding the role of gas testing in every diver's safety. The take home message was gas testing can save your life. Next up, from across the globe, Peter Buzzacott spoke on the importance of accurate incident reporting, and the understanding of that data. We are reminded that much knowledge and safety improvements can be had through studying previous incidents and trends. Following that important message, Kelly Jessop demonstrated the importance of cave stewardship through attaining and maintaining solid dive skills. Many times, the damage caused by a few can damage access rights to us all.

Following a short break, Dr. Richard "Harry" Harris wowed the crowd with the extreme logistics involved in safely extricating an injured diver from one of the world's most remote cave systems, located in his very own Australia. Many agreed that while the cave photographs were gorgeous, the reality of handling an emergency in such a place is beyond the endurance of many cavers. Lamar English followed Dr. Harris by recounting his own extreme diving situations. His exploration adventures had the audience's full attention, with hair raising, sobering, and comic tales.

Just before the break for lunch, NSS-CDS President Gene Melton gave the crowd an update on the current status of CDS and announced awards for Outstanding Volunteer to Cheryl Doran, Cathy Lesh, Xenia Mountrouidou, Shirley Kasser, James Garrett, Marissa Lasso, Rick Robinson, Bob Bost, Rob Neto, and Ken Elliot. He also announced a Safety Award for the Peacock Springs Line Committee, a Conservation Award for Fritzi Olsen, a Science Award for Jason Gulley, John Ezell, and Amy Brown from the University of Florida Science Research team, an award to Robert (Bobby) Franklin for being the 2012 Workshop Chairman, an award to Rob Neto for being the 2011 Workshop Chairman, Exploration Awards to Marbry Hardin, Jason Richards, and Christina Richards, and a Cartography Award to Karst Underwater Research.

Lunch was a real treat, with a delicious Mexican buffet catered by the "little Mexican grocery and café in Mayo." The vendors and the workshop attendees had the gym buzzing. The oohs and aahs from the art exhibit were a backdrop to conversations about past dives, future dives, new gear, old gear, and how to get one's dive buddy to unzip one's drysuit after eating burritos for lunch.

Not to be caught post-lunch napping, Brett Hemphill stirred things up with some exciting tales of exploration on the central west coast. His photographs and videos had every one perking up. Edd Sorenson came all the way from Marianna to discuss the benefits and merits of sidemounting. The gear configuration has been around a long

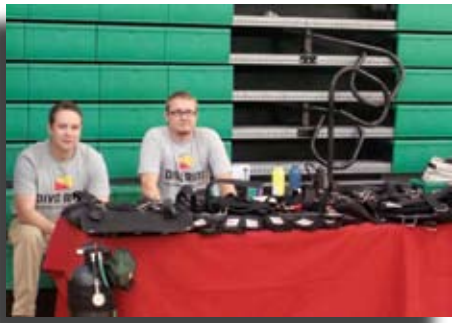
time, but has recently made huge in-roads into mainstream diving.

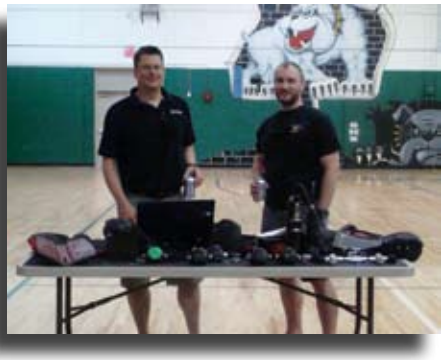
Jill Heinerth kicked off her presentation with an excellent video clip from an upcoming documentary film. She stressed the importance of our awareness regarding social media's role in current diving trends. The final talk of the day was Chris Richardson, who presented food for thought regarding the cave agencies' roles in cave diving training.

All too soon, the day was wrapping up and folks were heading out. Sunday was right on Saturday's heels, and there were several opportunities available for divers to learn new skills, try new equipment, and entertain new thoughts. Bobby's cloning secret would have come in handy to aid in attending all of the many clinics held on Sunday.

Sound like fun? Sorry you missed it? Now's the perfect time to start planning to be in Crawfordville, Florida next May 24-25 for the 2013 NSS-CDS Workshop at Wakulla County High School. I hope to see you there!

Photos: Gloria ***Euroza Vazquez***





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