

Bill Stone

Interview with an explorer & pioneer

Text by Peter Symes. Photos by Peter Symes, Bill Stone, Ken Corben, Paul Heinerth

Caves, rebreathers, risk assessment, the meaning of life, acceptable risks, the future of diving and what it takes to be a true explorer—Bill Stone lays it all out on the table for X-RAY MAG publisher, Peter Symes, who gets to hear about the dirt and glory of the birth of rebreathers through the eyes of the man who started it all with his pioneering efforts in closed-circuit systems.

X-RAY MAG: *You're a structural engineer by training. Are you driven by innovation, looking for applications or projects for your inventions – or do you find solutions for specific projects?*

Bill Stone: It was always the latter. It was the Pena Colorado expedition in 1984 that forced us to develop closed cycles systems because what we wanted to do was either going back to the Pena Colorado system or St. Augustine to continue. The game was that we were trying to beat the French for the world deepest cave. Now we are trying to beat the Russians, but it is still the very same game, and that is about the need to be able to traverse very long distances.

We were developing gear for ourselves to use to explore, and it was these two underwater tunnels that were driving the technology, and that was what very few people realize. They think we went to Wakulla (*Springs and caves in Florida —Ed*) because we wanted to explore Wakulla, but that's not true. We went there because I needed a place to test the Mk1, so I went to the state of Florida, and I

said I'd like to come down here and test this diving equipment because Wakulla is legendary.

In the diving world, it is a pretty amazing place, so it is has got this 100-meter diameter crystal clear basin with upwards of 70 meters immediately of depth you can work in. It is an ideal place to test rebreathers, and that is why I wanted to go there.

So, I submitted this proposal to the state of Florida, and ultimately, they came back to me. But in order to make the whole project go, we had to change a few things. Now, the other top covers in

Florida—who at that time included Wes Sklies, Sheck Exley, Paul Heinerth and a lot of other people—had put in a written proposal which, as a secondary objective, stated the continued mapping of the spring, because at that time, it had been closed for almost 20 years due to private ownership. So, they let us put that into the proposal as

We were developing gear for ourselves to use to explore and it was these two underwater tunnels that was driving the technology and that was what very few people realize.

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an objective because diving equipment had changed quite a bit in the past 20 years. The State of Florida came back to us and said, "All this is very interesting, but we are interested in the spring". So, they asked us to change the priorities and make the exploration of Wakulla Springs the first priority. We said, "Ok, that is fine."

We still got the permission to test the rebreather. So, as a result of that change of priority, we were immediately confronted with the problem that everyone knew the place was going to be deep, pushing 90-95 meters.

And so, we started thinking, as early as January 1986 or so, that we needed to do something about decompression.

Ultimately the design came out of this variable depth decompression habitat, this ice cone shape thing with 12,000



"Robots are not and will never be a substitute for human exploration, simply because it is in human nature to be curious"



is what became the Wakulla project.

It was kind of a sideshow that we did all this rebreather testing, culminating with this 24-hour underwater test we did on December 3rd and 4th, 1987. I did that in a Poseidon Unisuit, ending up reading two books underwater and also ended up filling the drysuit up full of pee. So, by the next afternoon, I was pretty darn cold. In order to stay warm, I had to come up with something. OK, Wakulla springs has got this 30-degree sand slope that goes down towards the entrance. So, I had all these guys bring in a lot of lead, and I would take my fins off and walk down the slope with my Mk1 on my back. I would then run back up to get warm; I just kept going up and down that hill. I did that all afternoon on December 4th to stay warm until I could get out.

When we got to the shore, there were about 12 journalists from various press, and we cracked this bottle of champagne. But the interesting thing about that was that we only used half of the supplies—half the life support that was in the rig.

X-RAY MAG: How did you get it all in there?

Bill Stone: Oh, we didn't get in the cave at all. It was really about testing the equipment. Did the electronics work? Does the breathing system work? What

The Cis-Lunar MK-2R included dual rebreathers and six onboard computers. Nigel Jones is shown debugging the initial embedded controller circuitry [photo ©1990 Bill Stone]

kgs of lead at the bottom of it. And we ended up getting ROLEX to fund that—the open circuits plus the vehicles which sleds and everything

Bill Stone

problems are there with breathing? There are a thousand little questions about how you use a rebreather that we learned for the first time in 1987—y'know, what works, what doesn't, what swimming attitudes were best...

We had streams of data from that dive and a dozen other dives, which enabled us to move on to more generations of the rebreathers all the way up to Mk5.

Exploring Huautla with Mk4s

But it was the Mk4 was the one that was specifically developed to go back to Huautla plateau to continue on the work we left off with in 1984. So, it took us ten years to get to the point where we were able to go back—as we did in 1994.

We used the MK4 to crack that tunnel that was 600 meters long, and we explored another 3kms on the other side before we hit another underwater tunnel at a distance of about 7kms from the

"That call of the raw unknown has a certain subliminal beckoning to a rare few true explorers"



Brief Bio

Doctor in Structural engineering, Ph.D. P.E

Professional Affiliations:

- American Institute of Aeronautics & Astronautics
- American Society of Civil Engineers
- Tau Beta Pi & Chi Epsilon National Engineering Honorary Fraternities
- Member, AIAA Task Committee on Aerodynamic Decelerator Systems
- Member, ASCE Committee on Space Engineering & Construction
- Member, CII Committee on Wireless Data Communications
- Member, ASCE Committee on Automation and Robotics in Construction

Holds 11 patents, including Digital Waterproof Lap Counter, Breathing Apparatus Mouthpiece, Breathing Apparatus Gas Routing Manifold, Breathing Apparatus, High Speed, Amplitude-Variable Thrust Control, Breathing Apparatus Mouthpiece, High Speed, Amplitude Variable Thrust Control Method

Technical Experience:

25 years of structures, dynamics, systems design, spacecraft, and life support research work, including the development of:

- Non-Line-of-Sight real-time metrology.
- Virtual construction site simulators.
- Automated control systems for construction machinery.
- Procedures for conversion of Space Shuttle external fuel tanks into safe, low cost laboratory facilities in low earth orbit.
- An intelligent, piezoelectric spacecraft reaction control system.
- The MK1, MK2, MK3, MK 4, and MK 5 Cis-Lunar rebreathers. ▶▶





PAUL HEINERTH

1998 - Bill Stone drives the 3D DWM (digital wall mapper) back to the surface at Wakulla basin

St. Augustine

When we went back to St. Augustine in 1994—we were there for 4.5 months and most of it went to logistical setup, logistical derigging—there was only one period of about seven days that we spent beyond that, on the underwater tunnel. All the rest in between were exploratory dives.

I think we did over 22 missions out of this incredible, remote place. People don't appreciate that there were 3km of rope rigged, and you—in order to get to this place—had to go rappelling down all these ropes just to get to the place where the dive started. There were 3kms of ropes going down into a hole in the ground where there were three underground camp sites, which were moving inwards day by day to get to the point where we wanted to be.

The final camp was located outside the dive site, and there was no dry land there. We had to build platforms suspended three meters above the water, so if there was a flood, we weren't going to be swept away.

There were hammocks on rock bolts in the roof, so we slept there. But we did 22 exploratory missions before we actually broke through. Some of those diver were of the order of two to three hours duration at 30 meters depth.

Of all those dives put together, the total gas consumption was 100 24-liter bottles of Heliox 86/14 and one 2000-liter bottle of oxygen. Those were our supplies for that entire expedition.

X-RAY MAG: *That must have been a logistical nightmare when you also considered food and other supplies.*

Bill Stone: Yes, and had we had more time—we still had the logistics of taking the rebreathers down to the sump—we would possibly have broken the world

Beyond the Deep by Bill Stone and Barbara am Ende chronicles the exploration of the "Most Treacherous Cave"—Mexico's Sistema Huautla. [Put in link](#)

Bill Stone



KEN CORBEN

1997 - Richard Pyle preparing for the first-ever deep dive with a MK5 rebreather

record that spring. But as it turned out, the thing was much more difficult when it came to the raw logistics. We had rope transport, food transport and what not. But from a diving view point, it was an enormous change.

It was when we came back that Richard Pyle contacted me regarding using the MK4 that was a leftover from the 1994 expedition, which was a National Geographic project.

At that point, he started off using MK5s, and we got the chance to go back to Wakulla Springs in 1999, and from that point, two things happened.

One, is that we commercialized the MK5 and sold 100 of those. The other was that we developed a lot of new equipment

for Wakulla Springs, including the 3-D mapper, micro sat systems and propulsion gear... and things like that. It has been a continuous string of expeditions. But from an equipment development view point, it has been driven by a desire to go some place that one wants to go, but wasn't able to get to before.

And that is really the thing. It wasn't driven by commercial economics or, "Hey, let's build this piece of equipment... Now, let's see what we can do with it". No, it didn't work that way.

We developed this gear for ourselves, and we were the test pilots. When you think that way, you design it completely different from somebody who designs it for the military. They are engineers and

- The portable 6-person underwater habitat used on the Wakulla 1 project and the launch system for the saturation habitat for Wakulla 2.
- An autonomous 3D digital full-wall mapper for automated cave surveying.

Selected Expeditionary Experience:

1994 San Agustin expedition (4-1/2 months), Oaxaca, Mexico, expedition leader. Reached -1475m beyond San Agustin sump.

1988-91 Four expeditions to Cueva Cheve, Oaxaca, Mexico (4 months total), expedition co-leader. Extended Cheve to present depth at -1386m.

1987 Wakulla Springs Project (10 weeks), Florida, expedition leader. Three kilometers of new discoveries mapped at 90m water depth.

1984 Pena Colorado expedition (4 months), Oaxaca, Mexico, expedition leader.

Nine kilometers of new discoveries near Huautla resurgence.

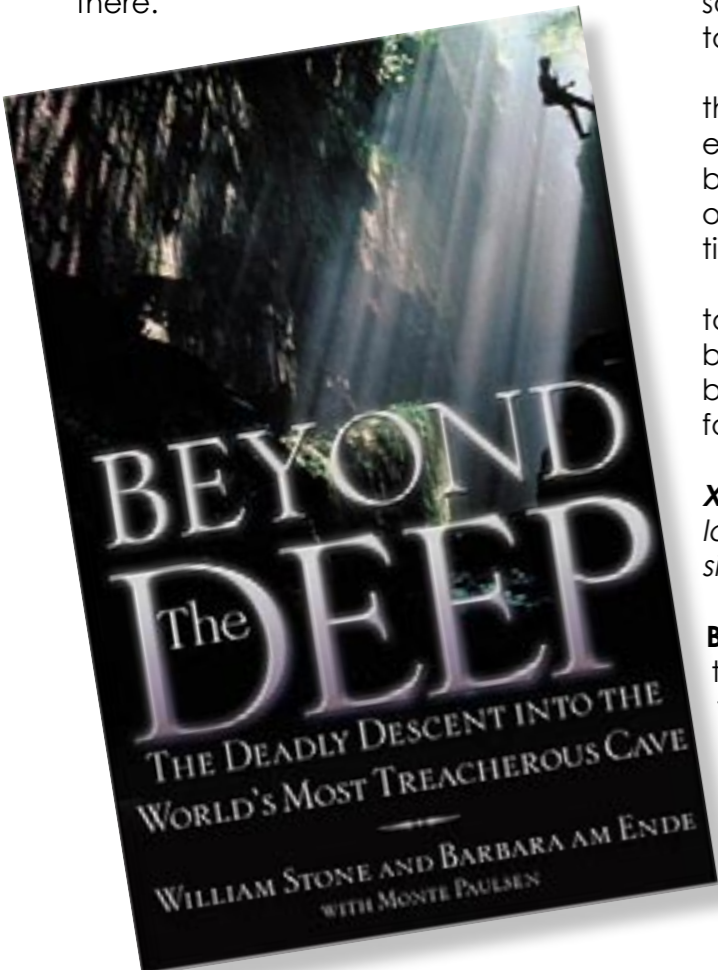
1981 Agua de Cerro expedition (4 months), Oaxaca, Mexico, expedition co-leader. Sistema Huautla extended to -1253m depth.

1980 Rio Iglesia expedition (4 months), Oaxaca, Mexico. expedition co-leader. First American team to reach -1000m.

they don't care. They are not going to use it, and if someone is going to die, so what? It is a military man, and occasionally, you are going to lose a few people—or something like that. Sure they might think it is bad if you lose someone, but it is not *them*—it's not *their* families.

In our case, we were the end users, and that makes you think completely differently about what you are going to design. You start thinking, how do I design this rig for survival? How do I make it lightweight, since I am going to carry it? How do I make it impact resistant? All these things.

X-RAY MAG: *I read a quote from your exploration of Cheve Cave: "When we*



Our World Underwater



BILL STONE

“It wasn’t driven by commercial economics or ‘Hey, let’s build this piece of equipment...Now, let’s see what we can do with it’. No, it didn’t work that way”

reached sump two (the second underwater tunnel—Ed), it felt like we were on the other side of the Moon—and that was still only a quarter of the way. To go all the way would be a +30 day journey in total darkness beyond all hope of rescue. But that call of the raw unknown has a certain subliminal beckoning to a rare few true explorers.”

Bill Stone: That is still true. That place is still a much greater exploration challenge than we experienced at Wakulla, which isn’t finished by the way. The reason why we left Wakulla is that we discovered Cheve Cave, which gives us the opportunity to beat the

Bill Stone

Russians. Wakulla does not. So, in these small international games we are playing, you go where the opportunity is.

X-RAY MAG: *But where is the limit—when you say, OK, I am doing something that is, quite obviously, very dangerous. I trust my equipment, but we are pushing it. Where is the edge of the envelope?*

Bill Stone: It becomes a psychological issue once you have broken certain ties. With the rebreather, we broke the tie with the compressor. We are doing the same thing with other techniques that contribute to the logistics.

This past year, we were working in another element of the Cheve system called the J2 and were 1200 meters deep and 9 km again from the entrance. These were separate pieces of a giant system

that focused together like a tree. The two elements were coming together in a nexus more than 20 kms away—which is incredibly remote. You can’t just imagine that. It is days and days of traveling time, and it is physically threatening in terms of i.e. huge water falls coming down. So, you have to constantly think, second by second. You can’t go lax. If you miss a connection with a carabiner...then

But to make a point... What we have learned is to minimize the equipment yet include what is most likely to go wrong.

So, a lot of thought goes into the spares kit. How do you repair something if it breaks? What happens if the

The reason why we left Wakulla is that we discovered Cheve Cave which gives us the opportunity to beat the Russians. Wakulla does not.

(What’s) Wakulla Project?

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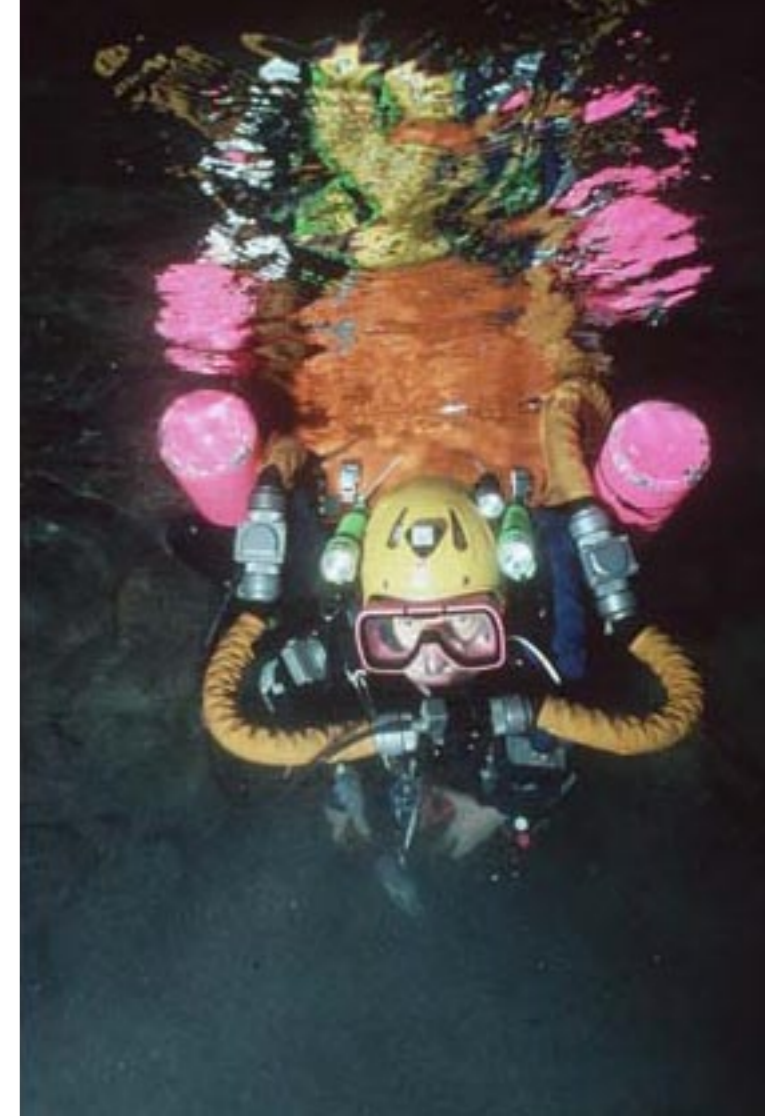
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The Rio Iglesia Falls at -1450 m. One of the most important discoveries of the 1994 expedition was the junction between the Rio Iglesia and the subterranean Rio San Agustin. Their junction forms the "Main Drain" for Sistema Huautla, through which the majority of the water for the vast karst plateau flows. Rio Iglesia, by comparison, carries nearly 4 times the water previously seen in Sistema Huautla. Barbara am Ende illuminates the spectacular 13 meter waterfall that marks the junction

Bill Stone



X-RAY MAG: So a big part of it has to do with dealing psychologically with being so far away? And the real barrier is that you can't go beyond what it possible logistically.

Bill Stone: Yeah. The thing you always need to be thinking about is what is the emergency bail out path, and what do you need in terms of the very bare minimum to make you comfortable to do that.

One of the things that has changed over the years is that we have developed a single wire communications system that we run with us. Normally, that was one of

tried fiber optics in 1994, and that had its own issues. But lately, we've been using this very thin single wire system that uses the earth, ground, for communication. Up at base camp, you just put a stake in the ground and with the proper amplification, you can actually talk with people across 9 km.

That has dramatically changed the logistics because there is less error in the communications. Before, it was all done by messenger that had to go back to the last camp, where another would relay the message on to the next camp and so forth. Now we just call the surface directly i.e. if we are running low on food.

X-RAY MAG: It sounds similar to the problems engineers are currently discussing in regard to sending people to Mars. How do you deal with it, not only practical sense, but also psychologically, when you have a little group of people who must get along a rely upon each other under stressful conditions in a remote location beyond any practical rescue?

...it makes you think about how you are going to fix things.

Bill Stone: As I said, it makes you think about how you are going to fix things. I believe that the Russians are far ahead of anyone in space in terms of fixing things psychologically. We are starting to learn that on the International Space Station—but, yes, that is how we think underground.

We always think about where our spares are, where our spare gas is... everything that you need to get out of there again in an emergency, but on your own. If you break a leg, and you are beyond a

couple of kilometers of underwater tunnels down 1500-2000 meters and 10 km from the entrance, there is nobody that can drag you out. There are not enough people in the world trained to do that. At the very best, we have started training people now to go back to J2 in 2008.

Going back with rebreathers

We hit a third underwater tunnel at 1200 depth. The idea is to go back there with very compact rebreathers. Put 6-8 people through there who are going to be self-contained for upwards of 25-30 days beyond the last crew at camp 3, and we will see how far we get.

The logistic maps that we have projected from that point onwards are looking at a 22-day round trip just to get to the most remote camp we expect to see established.

Usually, you then have about ten days exploration beyond this point. So, that will be 30, 35 or 40 days in total. We can do that in just a couple of years.

Last frontier

And there is no other place on Earth that you can do this. If you go into a jungle, you can be extracted by a helicopter. Pretty much the same thing if you are anywhere underwater—if you are in a submersible or whatever. But this is real exploration, and that is what attracts me. It is the last good frontier on Earth before we make the leap outward—and there we've got projects we are working on as well.

X-RAY MAG: What goes through your head when you come around the next corner and see the next section that

nobody has seen before.

Bill Stone: I used to have canned answers for when people asked me these things but in most cases, it is just more of the same, like another canyon. But every once in a while, if you have gotten past some really tough obstacles, sometimes when you go back to camp at night you get this wow-sensation... I had one of those in 1994 when we had gotten past the St. Augustine sump and 1 km beyond camp 6.

"This is it"

We had been going in and out of all these little bypasses and finally came to this one place, and we said, "This is it". There was another sump, and we had made a firm decision that we weren't going to do any more diving as we were only two of us and only a couple of people at the supply camp further back. So, we thought we better not screw up.

But we came to this place that went



"There is no other place on Earth that you can do this... This is real exploration and that is what attracts me"

those things we never did—the two-wire military systems didn't work well. We also

in an emergency, but on your own. If you break a leg, and you are beyond a

cable to the display on my rebreather breaks? What I am going to do? What if a battery goes flat when you go there? Or you tear a hole in your counterlung? All these ideas go into the spares kit.

When you go into these underwater tunnels with a crew, you start thinking where to place emergency depots and what should be in them. You always have to think of the retreat. Where to put rope stashes. What if someone breaks a leg? Then I need to have enough equipment to hoist the injured out. Where do I put sleeping bags?

If I make it to a chamber, I can't sit in my dive suit as I would go hypothermic. So, I need to have sleeping bags and foam pads and hammocks. So, how can you make those things as small as possible? How do you communicate with the people on the surface—that's a big one.



At about 2,900 feet (900 meters) deep, Marcus Preissner eases his way across a pool of water in Cheve's Black Borehole. For safety, expedition members carefully rig rope systems wherever possible

After 160 feet (50 meters) of squeezing through a ceiling collapse 3,200 feet (1,000 meters) down, caver John Kerr is on his way to more open terrain in Cheve Cave

tion. You couldn't see anything up, anything left, or right and nothing ahead of you. It was all total blackness. So it was like, I have just stepped onto the back side of Pluto.

I yelled, and that echo just carried on for ten seconds. That still sends shivers up my spine. Just to walk into a place like that, and you know that nobody ever even conceived that a place like this existed. It was over 200 meters wide and 80 meters tall, and it was more than enough to suck

up every photon that was coming off our lights. It just went on and on for quite a way until it finally narrowed back down to a general river passage. That is the kind of thing people get excited about if you go underground.

Just seeing blackness

The other really good one is coming around a corner and looking down and just seeing blackness. And you say, "That is an interesting place." You pick up a rock and toss it, and you start counting. After about

I yelled and that echo just carried on for 10 seconds. That still send shivers up my spine.

six seconds something clicks over in your head that goes, "Holy shit!", before you count to seven, eight, nine, ten... And the point when the rock hits the bottom, it still takes the sound a second and a half just to get back to you before you hear that roar down there echoing in the distance.

That sets off all kind of thoughts. The first is that you back away, right? Because you just realize that what you just thought was trivial, now turns out to be higher than the Sears Tower or the Petronas tower—and you are standing over it without a rope on.

The second one is "Oh man. We need to get a lot of rope."

When a buddy dies...

X-RAY MAG: *Do you ever get to the point where you start to question these explorations and whether it is worth the risk and when the price for curiosity is too high. For example, when somebody dies, like your friend, Ian Rolland, did in Oaxaca?*

Bill Stone: Yeah, there were emotions on all kinds of levels going on right then. Probably the biggest one in the back of our minds was—and probably in me more than anyone else on the team because I had designed the gear,

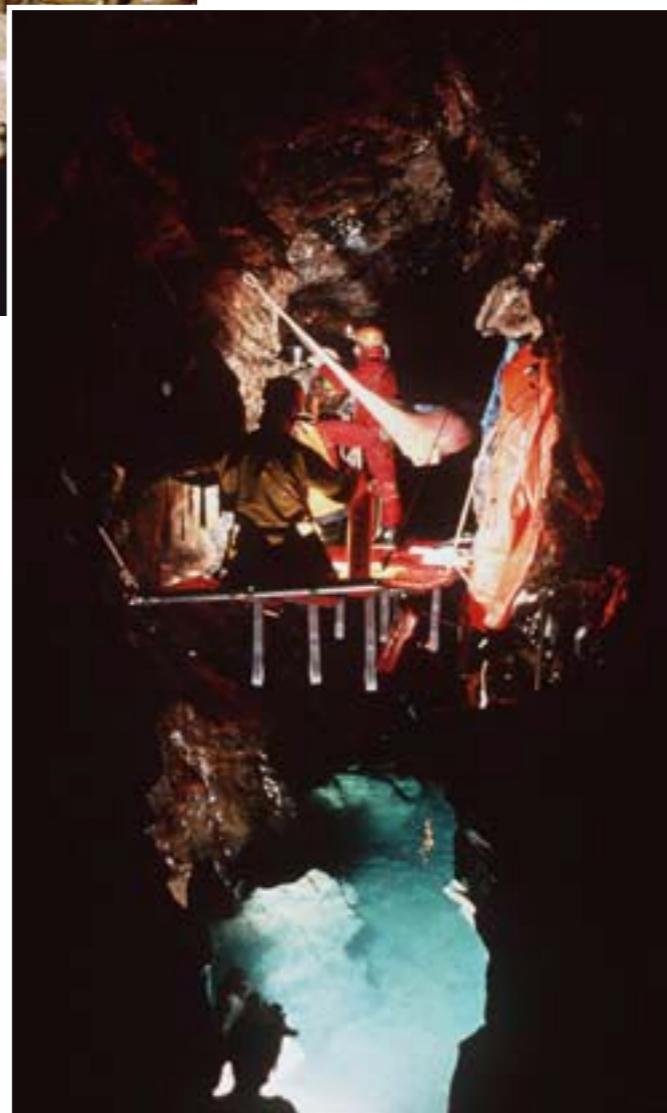


off in four different directions, and I looked at the three of them, swam over and took a look at them, but there was nothing there.

The final direction looked deep, with the ceiling coming down in the distance, and it looked like one of these low air spaces where you just have to taut your neck and put your nose up and then it ultimately becomes an underwater tunnel. Well, it was a mirage.

...the back side of Pluto

When I got further into it, the ceiling slowly started to lift up, and it was a reflection. So, it looked like it was closed. But suddenly, it opened up to this sand beach on the other side. From that point onward, you couldn't see anything in any direc-



although I knew the gear was good, I had no doubt about the gear—the real question was: *Why did he die?*

And nobody really understood that, and because of that, there was a lot of freak factor going on. Normally, rational people like engineers, scientists and technical people who should know better, were constructing gremlins: "If it killed him, it is going to kill me." So, the expedition almost collapsed at that point.

And that expedition had been ten years in the making—Wakulla was just an incident on the way to that expedition. So, by the time we got there and already spent four months on the site, it was like number one—yes, we lost a good friend. So, the question was, what the hell happened?

The second one was, we can't lose everything that took ten years to get this far. You don't think like this, if you have just come on board as a team member. But you do if you have organized it.

You got 60 corporate sponsors, National Geographic, Rolex... Everybody who would ever possibly back your expeditions in the future is sitting there silently looking over your shoulders thinking, "Well, what is he going to do?"

Half of you says: "I wanna get out of here. I want to get home." But the other half then says: "Wait a minute. There is too much invested. This is an unfinished piece of business, and we got to carry it through."

X-RAY MAG: *So, how did you handle it?*

Bill Stone: We stowed the equipment and then went over to England and had a big wake. Ian was a great guy. He was an extraordinary explorer. I can't say enough good things about him.

The one thing that was a problem for him was that he had acquired adult-onset diabetes about a year prior to the expedition. As he had been with the project for about eight years it was a very difficult subject to deal with. So, we talked with all of the endocrinologists and as a many experts that we could get hold of. They concluded that he was good and an asset to the expedition. And as long as he was able to maintain his insulin levels under exertion, then they couldn't see any reason to stand in his way. So, for 3½ months everything went great.

What we believe happened is the following:





Jack Harrison Schmitt on the Moon

He and Kenny Broad had just surfaced behind 600 meters of tunnels and found this earth-filled chamber. Now Kenny was not a dry cave explorer. But Ian was this multi-discipline guy who was not only a diver but also a top-rated rigger and dry cave explorer. So, I said to him, "Why don't you go?" And so, he did.

Well, in the world of exploration of underwater tunnels—particularly where low or zero visibility is a factor—it's generally consensus to do solo diving. That's a subject for another whole discussion—but this is just the way it is. If you go to the UK or anywhere else, they will tell you that a partner is a greater risk to your life than yourself with a whole lot of redundant systems.

So, Ian was over there, and in the excitement of doing what he was doing, he over-exerted himself. He actually had to get out of the water and walk 100 meters, and his gear was heavy.

We had the Mk4 plus two bailout bottles and tackle bag. That is probably 70 kg. He only weighed 65 kg, so getting out of the water and all that... But he had candy bars in his belt that he was going to eat. He then headed off, and he got about 30-40 meters into the next tunnel

"What you find, almost invariably, it is human error that kills"

where he realized that something was wrong and just didn't make it back to shore.

X-RAY MAG: So it was essentially the diabetes that killed him, not an equipment malfunction?

Bill Stone: Yeah, from hypoglycemia. Because, unlike any other piece of diving apparatus to that date, we had a black box in the MkV, and we interrogated it.

And sure enough, the Oxygen level was well within breathing range and there were no other signs of distress.

He didn't die from heart attack either. He was very fit. This was pretty cut and dry—we investigated everything. There is a 25-page report with all the physicians giving their say and looking at the data. The conclusion was, for sure, that there

was nothing wrong with the rig. We knew that for a fact, as Barbara Am Mende used the very same rig for the final push with no change.

Tough one

The tough part was, of course, learning that fact for the first time when Kenny Broad marched into camp three after midnight after everyone had gone to bed with the news that somebody is not coming back as planned. This happened periodically, and you just get this gut feeling that we got a serious problem and what are you going to do? You just got to go do it.

Kenny did the reconnaissance to find out what happened, and I went in to collect the data. We actually had slates on which we wrote up all the dates in case the battery died. Power was still running though, so we got a huge amount of data just off the screen in addition to what the black

Everybody who would ever possibly back your expeditions in the future, is sitting there silently looking over your shoulders thinking, "Well, what is he going to do?"



Bill Stone

I never considered myself a diver. It was just an exploration tool for going deeper into the Earth

You try to rationally limit the risk to the point where you hope that you can reduce the probability of hardware failures that will kill you—or environmental factors that will kill you—as much as possible. And what it then really reduces down to is the probability of human failure.

I have lost 16 friends on expeditions—not all on my expeditions. We had four fatalities on the 53 projects that I have run. What you find, almost invariably, is that it is human error that kills. So, what do they do?

A lesson from Cheve Cave

Well, there was this fella in 1991 in Cheve Cave who came down and—against all advice—tried to go to a second underground camp straight from the surface. Well, the distance was too far, and he got fatigued and started making mistakes until finally, when he was going down a fairly steep shaft—and you have re-rig points on the ropes to prevent abrasion and things like that—he just didn't clip in for safety, and he put his descending device on the rope below, and jumped on to that.

Guess what? That clip, that carabiner, that connected to his harness was not locked. So, here we have three errors in a row. One, caving while he was fatigued. Two, not clipping in his safety device. And three, not bothering to check whether it was locked for his descent.

All these things summed up. So, ultimately when he sat down, his carabiner

box recorded. So from then on it was just: "Ok, all right, how are we going to get him out of here?"

Risk assessment

X-RAY MAG: So, are fatalities like that are just a price that you have to accept when exploring?

Bill Stone: In 2004, NASA asked me to participate in a very small workshop on risk and exploration. There were some wonderful proceedings that came out of it. There were mountaineers and astronauts like Jim Lovell from Apollo 13, Jack Harrison Schmitt and others of that caliber. What we concluded was that exploration, by its very nature, is...risky.

Look for the signs that tell you when things don't feel right. And if you sense those signs, stop.



BILL STONE

Careful to avoid rocky edges and a roaring waterfall (right), members on the 2003 expedition take turns dropping 490 feet (150 meters) into the vast beauty of Saknussem's Well in Cheve Cave.

involved at the bottom of a deep cave—in particular if I am not the lead diver. I take the person aside and I say: "Look, don't let those people pressure you into diving if you don't like the situation you're in. If you get down there—you might have had 25 support personnel turning all of your equipment, rebreathers, tanks, back-up lights, reels ...everything, hundreds and hundreds of kilograms of gear kilometers down there, and it might have taken four or six weeks—and you find you have a leak in a high pressure hose, or you don't like the way the electronics are powering up on your rebreather, then abort. That is it! No question asked. Stop! And then reassess."

Control & stress

Bill Stone: To me, I start to lose stress when I arrive at base camp, because then I am in control. And that is one of the beautiful things about exploration

in my mind, at least here on Earth, because you are dealing with a static adversary.

Now, it might be slightly different underwater, you may go into a place and while it has very low probability, a lot of sharks may show up. That is what falls into the category of unknown or uncontrollable risks. That is, by the way, the reason why I don't do high-altitude mountaineering. There are too many uncontrollable risks, like weather, crevasses that you don't know the shapes of, avalanches... Some of the best mountaineers in the world are dead simply because of random probability, such as they were in the wrong place when the avalanche occurred.

To me, it is about choosing your frontier—but mountains are not frontiers anymore. They have been climbed. We

have them underground and underwater. That is what is left. And in our free time we are trying to figure out how we get back to the Moon.

X-RAY MAG: *What is the main thing about exploration that gets you?*

Bill Stone: It is about the thrill of going some place where no one has gone before. For a tech diver, it might be about going down and finding a 500-year old galleon or something. I can really appreciate the excitement in something like that. It is just not where I would like to go. I like geographic exploration as opposed to artifact localization and such. But the feeling for those people, I believe, is the same. It is what excites you in life. It is the curiosity that you are satisfying.

X-RAY MAG: *So, if you were to sell the idea of diving to a mixed audience, what would you emphasize?*

Bill Stone: If you talk about strictly diving, I never considered myself a diver. It was just an exploration tool for going deeper into the Earth that I was looking for. I never spent much time in the ocean. For many reasons. One being that when you go into the ocean you are entering the food chain, and therefore, you are entering a higher risk environment that is unpredictable, and I like to control risk. That is one thing.

But, I was out in Hawaii with Richard Pyle, and that was shortly after the MkV had become commercially available. We

Bill Stone struggles through John Kerr's dig in Aguacate's sump (flooded tunnel) bypass

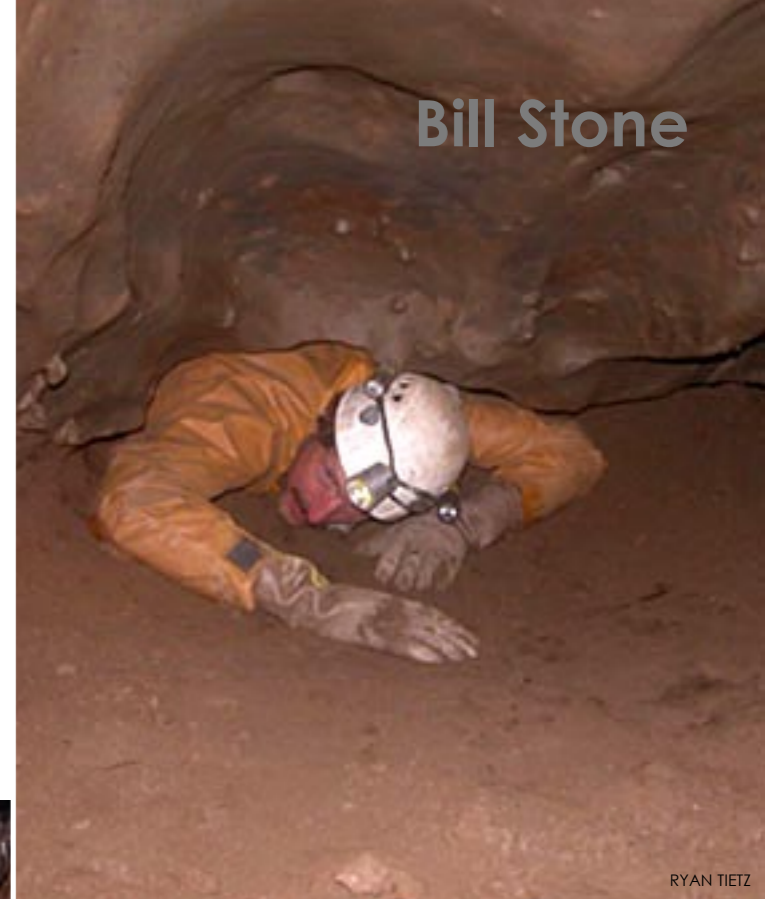
went out and did a dive on corals and followed a slope down and ended up at plateau around 87 meters where Richard showed me some of the wildlife.

We spent a couple of hours down there, before we decided to go up. Then, as we hung out at around 40 meters with some hours of decompression still to go, Richard suggested that we go over to have some fun around some commercial tourist submarines.

They were a couple of kilometers away, so we started swimming, went over there and swam back, doing our decompression all the



ANDY HUNTER



Bill Stone

RYAN TIETZ

way along. When we surfaced after about six hours we felt great—as we were diving on Heliox and didn't really think about the distance and time we had spent underwater.

It was only afterwards, when we got back to shore, we both realized that this had been really special because we felt so natural and at home down there completely forgetting about the fact that we were underwater and for that long. It was like, "Hey man, let's go over there and see the subs, what the hell?"

How many people would decide to go on a four-hour swim at 40 meters depth and come back and think nothing of it?

It didn't occur to us that this was anything eventful. We had just suddenly become elements of the environment. We were just underwater and that is where we belonged. And coming back up was actually the stranger part.

That is what sold me on rebreather diving. I believe that kind of experience is life-changing for people who experience it. You won't get it with open circuit scuba. It was a fundamental change during which we lost contact with the

2004 - Bill Stone rappels out after completing the second pitch of the Aguacate dome climb





BILL STONE

After traversing 4.6 miles (7.5 kilometers) from Cheve's entrance, caver Bart Hogan wades through the entrance of a gorge 4,300 feet (1,300 meters) deep. The team schedules its trips to Cheve in the middle of Mexico's dry season to avoid dangerously high water levels and flooding.

Bill Stone

today is too big and bulky and only something that your typical male tech diver will wear.

It is not a thing that a teenager or the average adult female diver finds desirable. So, how do you design a comfortable unit that everyone can easily carry? Secondly, how do you design them so they are inherently safe?

Because rebreathers have followed a technical dive path and been associated with complicated projects, all kinds of stories also flourish—like if you are going use them you are going to die on them.

Yes and no

They were complicated technical devices that in many senses were over-engineered with a lot of options. But if you start looking at the problem

from the other end and look into designing them from the ground up, where the rig is looking after you and the procedures are simple—so you can get the perfect rebreather experience—this will all change. That is the next threshold.

Rebreathers need to be very small and very light and look after you.

The revolution is coming

But this step is already on the horizon, and when it happens, diving is going

Almost everything will be closed circuit because it is so cool... It will not be a toy. It will be the beginning of the revolution”

to be revolutionized. Because people will start realizing they can start on a rebreather and not open scuba where you learn some nasty skills that have to be unlearned later when you go on rebreathers. Once the training organizations realize this, everybody will shift and fall in line.

So, you will have: Intro to rebreather, Advanced rebreather, Technical rebreather courses and so forth. But a lot of other stuff will be gone, such as nitrox and trimix, as it is inherent in the rebreather.

It can happen soon, as early as in the next two to three years. I don't think any longer than five... Market forces will drive it that way. Once the Club Med diver has started having fun on these, that will be it.

And all those tech divers that are out there now... they are going to look down on it and call it a toy. But it will not be a toy. It will be the beginning of the revolution. Eventually, they will start tinkering with it too, because it can fit in your suit case.

To me, there is another aspect to it and that is, once you understand how it works, and you have it working well, you have all the time in the world to resolve problems underwater. One of the leading causes of fatalities with open circuit diving is panic in wrong situations. But on a rebreather you are not going to alter the duration if you breathe a little faster—you still have hours to figure it out.

I believe they are safer in every respect. They require a different discipline than open circuit, but I take that they are much safer. So, when you see

500,000 rebreather divers as opposed to 500,000 open circuit divers, I believe the accident rates will be lower because you won't have panic failures and time related failures that will kill people. There you go. ■

fact that we were in this environment.

This is what the new diving experience is going to be and it is coming with rebreathers. There will be institutional resistance. But it is going to come to a point where rebreathers will supplant open circuit diving. Almost everything will be closed circuit, because it is so cool.

X-RAY MAG: What will it take to get to that point? What are the main challenges when it comes to technology, physiology and pedagogy?

Bill Stone: There are two fronts: How do you build something that is really compact? Everything we have



Once the Club Med diver has started having fun on these, that will be it.

Poseidon??

