MEASURED

Elegance

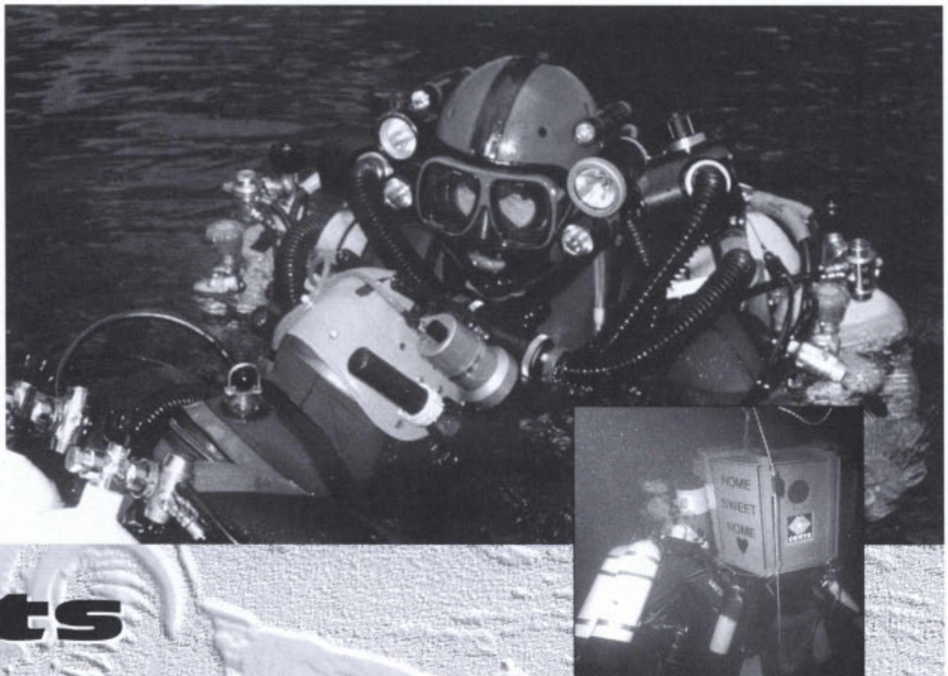
by Olivier Isler

On 31 December 1989, I completed what I believed to be the first major dive in a siphon using a semi-closed circuit system designed and conceived for that purpose. Eighteen months later I was astonished (as was the European cave diving community) to learn that Jochen Hasenmayer had made a number of remarkable dives using a rebreather some nine years earlier as reported in *The Darkness Beckons: The History and Development of Cave Diving*, by Martin Farr.

I shall steer well clear of criticizing the renowned Hasenmayer, who will certainly remain one of the greatest pioneers of cave diving. However, whilst my original assertion now seems unsound as a result of the lack of information on my part (Hasenmayer was always very secretive), I still believe deep down that I am right. Hasenmayer's most outstanding dives were conducted using open circuit technology, perhaps indicating a lack of faith in his new device. In my case the reverse applied.

At least three factors contributed to my decision to seek a different technological approach to underground exploration beginning with the existence of an extraordinary siphon, La Doux de Coly. In 1984 I penetrated a distance of 3100 metres/10,170 feet in that source with the average depth of nearly 50 metres/163 feet. I accomplished this with an enormous back mounted aqualung (five 20 litre cylinders, or 23 cubic metres of gas—about 812 cf) along with many more cylinders for back-up and emergency. I could have continued the push but it would have required a massive investment of energy. Very long dives would be necessary to place and retrieve the necessary stage cylinders before and after the main exploration push. These would have called for a formidable team of assistants serving a single exploration diver, much like the old Himalayas expeditions. Instead, I wanted to bring a measure of elegance to the way La Doux De Coly and other underwater caves are explored. La Doux De Coly provided the needed impetus to develop a unique type of self-contained aqualung.

The second contributing factor was a physiological handicap. Being very tall and weighing 78 kg (172 pounds) presents a drawback from a physiological standpoint since my body's metabolism requires a substantial intake of oxygen. In quantitative terms, I use approximately 25 litres of gas per minute (about 0.9 cf) when swimming underground. With a rebreather, this problem no longer exists.



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Designing a life support apparatus is one thing; using it to venture into an unknown siphon is quite another. Our first dives were somewhat stressful from a psychological standpoint because of the experimental nature of the equipment. Looking back over the dives we conducted and analyzing the parameters of long stays underwater, it was clearly much safer to set off with the RI 2000 on one's back; if only because of the fact that a tiny part of the systems capabilities were actually used. In spite its many deficiencies, we believe that this aqualung will have played a minor but unquestionably significant part in the history of diving exploration.

Thirdly, I had the good fortune to meet Alain Ronjat, an electronics engineer who was fascinated by the intricacies of breathing apparatus. Between us, with just over 5000 hours of hard labour, we designed the Ronjat Isler semi-closed system, which we named the RI 2000.

The choice of a semi-closed circuit system

In theory, closed circuit technology would seem to be the obvious choice for exploration as it offers maximum performance, reduced weight (for the same weight, a closed-circuit system lasts about four times as long as its semi-closed counterpart), a constant partial oxygen pressure that can be set at an optimal level for the environment and the ability to carry out the total decompression with a single system (i.e. no need for additional cylinders).

In practice, however, the advantages of closed circuit proved less devastating than one might have imagined, whilst the semi-closed system has two advantages that are of critical importance for a small team of amateurs beginning with simplicity. The design of a reliable closed circuit system requires a considerable investment in human and financial resources. This is not the case with semi-closed technology. Moreover, the complexity of closed circuit systems inevitably brings greater risks of failure in operation.

A further advantage is the fact that the system uses pre-planned gas mixes with known characteristics. This makes it possible to return to safety even in the event of a serious failure in the electromechanical system.

The RI 2000

The RI 2000 is actually a version of the semi-closed systems currently in use by the French Navy that has been adapted for cave diving.

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Long hours of difficult work were carried out to accomplish this focusing on three main features: ease of breathing, safety and performance.

Ease of breathing is critical in the hostile environment of cave diving where water flow can precipitate shortness of breath and increase CO_2 levels. Our modifications included the addition of an electronically-controlled solenoid valve in order to stabilize the partial oxygen pressure in the breathing mixture. This eliminated the breathing discomfort caused by mechanical leakage. In addition we increased the cross-section of the end couplings, injectors and filter cartridges in order to reduce load loss and carefully positioned the breathing bag in the back pack to be at virtually equal pressure with the lungs.

To increase safety, the RI 2000 was designed to accommodate three fully-independent circuits: two dorsal and one ventral **(see photo)**. The latter may be removed to reduce the physical bulk of the diver when considerable freedom of movement is necessary to perform a particular task. In addition, great attention was paid to pack protection and duplication of the injectors for each circuit. Finally, the use of two different mixtures in the six cylinders of the set allows three cylinders to be allocated for each mixture, thus any of the three circuits available can be fed using snap-fit couplings.

The performance of a semi-closed system depends on the flexibility of the respiratory circuit as well as the depth and the quantity of gas carried.

The latest version of our system, Evolution II affords great flexibility than earlier models and can be used for depths of up to 100 metres (325 fsw) or more. The duration time at maximum depth is around 7 hours in accordance with the Rule of Thirds (Use 1/3 of the gas for penetration, 1/3 for the return, 1/3 is held in reserve—ed). At a depth of 50 metres (163 fsw), the duration time is about 12 hours.

Operations

The RI 2000 is extremely comfortable when diving but the potential user requires a period of training. Compared to a conventional aqualung, this new apparatus requires sensitive handling and sustained concentration on the part of the diver. Mishandling when changing an end coupling or gaseous mixture can entail serious consequences. In addition, preparing the set for operation demands great care and more time than an open-circuit system, for example in packing the soda lime scrubbing agent. It is also advisable to plan and train for "disaster scenarios"; for example a failure of the entire electromechanical system in the three circuits (fortunately, an uncommon occurrence!).

The system was conceived and designed for long-distance diving. It is therefore heavy (115 kg—about 254 pounds) and relatively bulky, which means that the diver cannot get out of the water alone, for example, after crossing a siphon. However, when submerged its hydrodynamic characteristics are most satisfactory and enable the diver to swim 25 metres/minute (82 fpm) without too much effort, or to straddle two coupled boosters (stage bottles) with great comfort.

Though performance levels are significantly less than those of closed circuit systems, the RI 2000 greatly expands the options offered by conventional open circuit scuba. In theory, it is possible to conceive of dives well in excess of 24 hours. However other physiological limitations apply particularly with respect to thermal considerations. Except in the rare case of a very temperate environment (water temperature above about 28-30° C or 82-86°F), wearing a dry suit is an essential requirement. In Europe, where the water temperature generally fluctuates between 7-13°C (44-55°F) the thermal comfort of the diver is of paramount importance. Even minor details become significant. That is one reason I developed a system for urinating outside my dry suit. This addition dispels the abominable odor and avoids the need to undergo lengthy decompression stages with very chilled feet!

The Future

For a number of the reasons outlined above, the future of the RI 2000 is unclear. Whatever the outcome, we believe it will have established itself as a precursor for major operations in the years ahead. Such operations will inevitably become increasingly sophisticated from a professional standpoint and will require considerable investments in terms of human and material resources, thus making them less accessible to amateur divers. This is of course regrettable, but a wholly logical progression.

With regard to the future prospects of rebreathers for sport diving applications, I believe their widespread adoption is unlikely. Indeed, it seems that only extreme situations fully justify their use. For "standard" diving such equipment represents an unnecessary and costly luxury.

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