THE SULPHUR SPRINGS EXPLORATION PROJECT

Abstract of Initial Findings

History

Sulphur Springs is located in Hillsborough County, Florida in a heavily urbanized area of Tampa on property owned by the City of Tampa. In the past, the spring had been open to the public as a park and swimming pool. In 1986, the spring was closed to the public due to high concentrations of coliform bacteria.

Karst Underwater Research explored Sulphur Springs to provide the city with survey data of the cave system and identify possible intrusion points within the system. The city also expressed an interest in the fluctuations in the chloride levels at the spring.

Hydrology

The spring discharges an average of 44 cubic feet per second(cfs) into a concrete retention pool 50 feet in diameter. A set of weirs on the south side of the pool control the discharge of the spring from the retention pool to a 500 foot run that feeds the Hillsborough River. During periods of drought, an adjacent pump house is activated to pipe the water about two miles away to a city drinking reservoir.

The main contributor to the pollution is a series of sink holes extending three miles north of the spring. Storm water and street runoff are directed into these sinks via large drainage pipes.

An environmental study contracted by the City in the late 1980's provided tantalizing information about what the system might be like. Dye tests at various sinkholes north of Sulphur Springs indicated that one sinkhole about 5,000 feet north of the spring was hydraulically connected. Two other sinkholes, approximately 8,000 feet north of the spring, connected directly into the system and two others (Curiosity Sink and Blue Sink 5), which are approximately 12,000 feet from the spring, directly connected to Sulphur Springs. Curiosity and Blue Sink have been filled in since these dye tests were performed as a result of a land collapse during nearby construction.

The predominant limestone layer in the system is the Tampa formation. The limestone is yellow to brown in color and soft and course in consistency. The system has depths ranging from 30 to 118 fsw. The softest layers appear to be in the 30-40 fsw range. The limestone is cut with layers of clay that appear to be responsible for most of the breakdown as rock separates along these clay lines.

Biological Studies

The floor, ceiling, and walls are covered with a fluffy brown detritus. In some places these deposits were over six inches thick. Every move -- every exhalation -- sends this detritus bellowing everywhere like a blizzard. Samples taken of this papier-mâché-like matter later revealed that it was actually pulverized plant matter -- broken down to the cellular level. Interestingly, nothing living was found in the samples examined by the city. It is suspected that the detritus is introduced to the cave system along with the coliform bacteria at the Poinsettia and Orchid Sinks.

On later dives, brackish water vents were discovered. These vents had developed during the project and were not present on earlier dives. Surrounding these vents, white hair-like growth developed and flourished in the mineral rich water. It was noted that the flow from these vents fluctuated and when the flow diminished adequately or ceased, these growths died. The main tunnel leading southeast from the terminal room had only minor (weak flowing) salt vents when first explored. On subsequent dives, the brackish flow from these vents and others further upstream had increased significantly. The largest tunnel (bearing southeast from the terminal room) had changed from containing minor salt vents to issuing enough brackish water that the entire tunnel became a light-refracting halocline. As the salt flow increased from deeper in the system it was noted that the vents first discovered closer to the entrance had ceased to flow. During this transitional period there was little to no rain fall. The initial salt vents were discovered following a period of significant rainfall. All

salt producing vents found to date have been between 80 fsw and 118 fsw.

As a result of the elevated levels of salt water in the system, free-floating, jelly-like organisms were identified throughout the system and in the basin. None of these organisms were present prior to appearance of the first salt vents. These organisms appear to be originating deep in the system and carried out by the flow. Samples taken indicated that these organisms are *Thiothrix* (a unicellular gliding bacteria that derives energy by converting hydrogen sulphide into elemental sulphur).

Currently, efforts are being made to correlate fluctuations in the salt inflow in the system to rainfall and aquifer recharge.

Cave Exploration

Sulphur Springs

From discussions with local cave divers and city officials, KUR was told that there had been no divers in the system to date. During the mid 1980's, a few local cave divers were granted access to enter the spring, but found the flow to be too great (with no hand holds), and the opening too small. In the late 1980's one cave diver was able to get through the entrance restriction with a sidemount setup. After this initial dive, the city decided it was too risky to allow diving, and again halted access to the site.

In March of 1994, Jeff Petersen and Frank Richardson negotiated an agreement with the city to allow exploration of the spring to help with ongoing effort to find a solution to the pollution entering the system. The initial KUR team members consisted of Curt Bowen, David Miner, Jeff Petersen, and Frank Richardson.

Sulphur Springs contains almost every negative feature associated with cave diving: low visibility, heavy silt, extreme ceiling/wall percolation, high flow, restrictions and soft/unstable limestone.

A thick layer of detritus covers everything within the system, nearly zero visibility results on all exit phases of dives that involve exploration of new passages. As a result of brackish intrusion, the water maintains a hazy quality that (when coupled with the light-eating detritus covering the walls) yields 20 foot visibility under the most optimal conditions.

Tunnels range in size from 3' X 3' to one large room with average tunnels being 10' X 10'. The floor of most tunnels is covered with breakdown varying in size from boulders to fist-sized rocks. Some areas have sand dunes and clay beds.

Because of the initial restriction, sidemount gear was used on the first three dives. Thereafter, the restriction was excavated enough to allow divers to squeeze in with back mounted doubles. Later, a PVC ladder was tied into the bed of the entrance to allow divers easier access; a rope was attached to pull stage bottles and scooters into the system.

Stage bottles were introduced to allow further exploration. The final two swim dives consisted of triple stages and doubles. Due to the high flow and intrinsic inefficiencies of carrying three stage bottles, the maximum penetration from the entrance was limited to 2,700 feet. Set up dives were planned but never executed due to scheduling difficulties.

The decision was made to use scooters to reduce the work load on the dive team. Using Teknas and Aqua Zepps an additional 500 feet were added. At this point, the tunnel appears to be impassable without resorting to sidemount techniques to negotiate restrictions where inflowing water is apparent.
Due to the low visibility, efforts are continuing within the area from 1,800 feet to 2,700 feet to identify any other possible side tunnels. Surveying of smaller/ancillary tunnels continues. Maps presented are drafts only.

As of the date of this document, approximately 5,000 feet have been surveyed with a maximum penetration of 3,200 feet in the tunnel that appears to be headed for Alaska Sink and a maximum penetration of 3,600 feet in the main tunnel where the primary flow is coming from Poinsettia Sink. There have been approximately 60 dives in the system to lay line, survey, and collect samples.

Alaska (10th Street) Sink
Two dives at this sink (on private property) indicated an extremely narrow restriction (10-12 inches) at the base of the debris cone with a silty bottom. No flow was detected on either dive. Because of the extremely silty conditions, further efforts at Alaska have been suspended until the KUR has pumped out some of the silt to clear the passage. Water in the sink was significantly clearer than at Sulphur Springs, having a gray tint rather than the green-brown tint of Sulphur Springs' water.

Poinsettia/Jasmine and Orchid Sinks
Five dives have been attempted at this site (on City of Tampa property). Flow was noted at the bottom of the sink. The upstream tunnel has a limestone ceiling, but is currently impassable due to collapses of surrounding earth. The blue-tinted water issuing from the upstream tunnel is the clearest noted throughout the system. Efforts to excavate this opening to make it passable resulted in another collapse; efforts upstream have temporarily been suspended. The downstream openings are all in soft earth and take in considerable water including plant matter. Although one of the downstream openings is slightly larger than the upstream open, no effort has been made to penetrate this tunnel due to the instability of the surrounding earth, the siphoning effect, and decreased visibility.

Orchid Sink (one block south of Poinsettia/Jasmine Sink) is a dry sink. The sink contains drainage pipes that direct water from rainfall into the basin. After heavy rain falls, the water swirls clockwise until it is dry again. It is suspected that the sand layers just below the surface at the bottom of sink are responsible for grinding up the plant matter before it filters into the cave system.

Curiosity Sink, et al
Two dives were performed in the curiosity sink area (City of Tampa property). One was performed at Blue Sink to confirm that no opening remained after the reported collapses from nearby construction. The flat, leaf-covered bottom of the sink was a level 5-7 feet with no apparent flow and tannic water.

A second dive was performed at a spring located in the Curiosity Basin (on private property). The owners of the property reported a strong flow prior to the Blue Sink collapse. Subsequent to the collapse, the resulting back up of water in the basin and increased hydrostatic pressure has significantly diminished the flow from the spring. The owner reported intermittent flow apparent at the surface. The reconnaissance dive indicated a tree limb choked entrance with no flow.

Dive Planning/Safety Considerations

The following protocols were established and revised by KUR over the course of the project:

On all exploration dives, new line would be surveyed on the way out so that a revised map could be generated after each dive.

All tunnels that connected directly to the mainline and were easily passable were "T'ed". Line arrows were placed on all T's on the line indicating the most efficient exit tunnel. Gaps were placed at tunnels that would not be normally swam; where gaps exist in the line, the gap distance is typically 1-2 feet for these less traveled tunnels.

Team members used air to allow the most flexibility for exploration in the event that deeper sections were discovered. Later EAN 30 and EAN 32 were used to reduce decompression for dives where bottom times were expected to exceed 100 minutes. Oxygen was used on all dives for 20 and 10 foot stops.

Scooters were initially ruled out because of the poor visibility. When visibility improved in the system (due to decreased rain fall), both Teknas and Aqua Zepps were used for penetration beyond 1,600 feet. Aqua Zepps were favored because of their neutral characteristics. The Zepps were run at the "2" setting which equated to a swimming pace in the high flow. This minimizes risk of accident and damage to the cave while conserving gas. Scooter dives were limited to two divers to minimize silting.

For multiple stage dives and scooter dives, one individual would retain his stage bottle after the drop off point. In the event either person had a complete failure of their doubles, the stage could be used until the team returned to the other stage.

For some of the smaller side tunnels, solo dives were performed to minimize the potential entanglement and communication problems in the inevitable zero visibility on exit. Solo divers either carried a buddy bottle (aluminum 40) or used sidemount configurations.

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