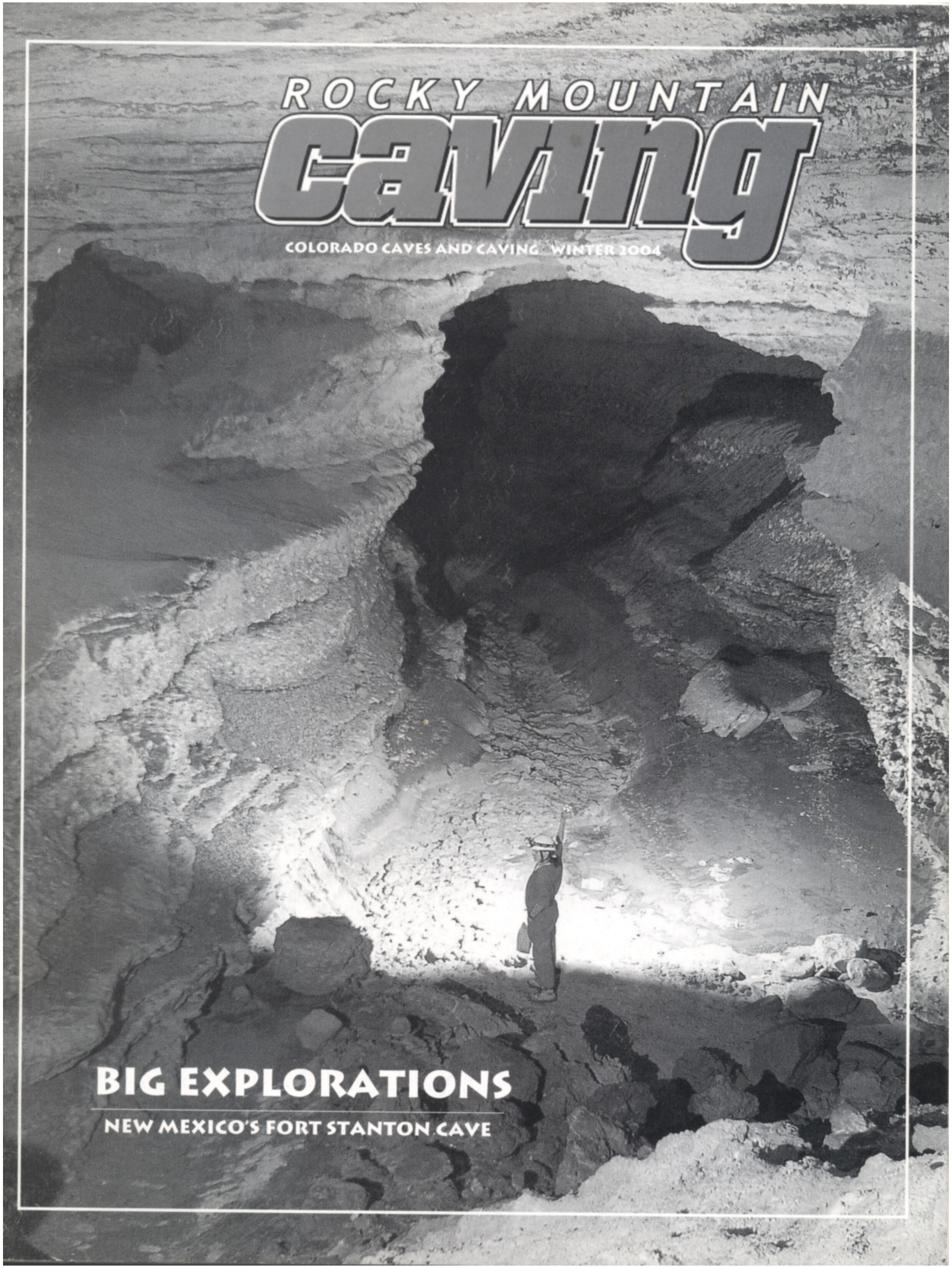
ROCKY MOUNTAIN
caving
COLORADO CAVES AND CAVING WINTER 2004
BIG EXPLORATIONS
NEW MEXICO'S FORT STANTON CAVE

The Exploration and Survey of Snowy River

PRIORITY SEVEN

Fort Stanton's New Frontier

BY DONALD G. DAVIS

INDEPENDENCE DAY EXPEDITION: JULY 4, 2003

I had been aware of the Snowy River breakthrough in New Mexico's Fort Stanton Cave since September 2001, when Lloyd Swartz, John McLean, Don Becker and Andrew Grieco penetrated the final obstacles in the long and dangerous Priority 7 breakdown dig. Since then, the need to gate the dig, and a Bureau of Land Management requirement for an Environmental Assessment, had suspended further exploration. I had participated in some of the first efforts in that dig ca. 1970, so was considered by John Corcoran, the current Fort Stanton Cave project leader, and the explorers to be qualified to participate when surveying was allowed to resume.

This opportunity came in July 2003. Mike Bilbo and the FSC project leaders scheduled a pre-survey assessment trip, including scientists, restoration specialists and BLM staff, to visit Snowy River on July 2. The group was to report back to the BLM as to methods needed for protecting the unique Snowy River pool deposit from damage. The usual strategy for establishing trails through delicate new caves is to place the route through undecorated parts and avoid touching clean secondary deposits. For Snowy River, it appeared likely that an opposite means—avoiding all contact with earthy material while confining travel to the calcified channel—might be more suitable. This non-intuitive approach would require innovative procedures if the calcite was weak. Under consideration were special plastic "snowshoes" devised by John McLean, and laying down a rotating series of inflatable camping pads over the white crust. This group also was to take in a voice-transmitting cave radio made by Bob Buecher for BLM. The evaluation team was to be followed the next day by a survey team including all of the original discoverers of Snowy River except Becker.

The assessment team included Mike Bilbo (BLM Cave Specialist), Dan Baggao (BLM biologist), Penelope Boston (NM Tech microbiologist), Mike Spilde (UNM mineralogist/geomicrobiologist), Lewis Land (hydrogeologist and liaison to National Cave & Karst Research Institute), Kevin Glover (USFS restoration specialist), John Cochran (photographer), and Kathleen Rix (science support). The assessment trip did not go entirely smoothly. The key to the Priority 7 gate was forgotten, and Kat Rix was sent back out for it. Later, one party member had trouble getting back through a squeeze in Priority 7, and called on the radio after 3 a.m. for John McLean and Lloyd Swartz to come in to assist. They did so successfully, but the assessment team was in cave more than 21 hours—much longer than intended.

Some BLM staff members were also notified of the problem, and drove to FSC and stood by until the cavers came out. This event proved the value of the voice-transmitting radio contact. Without it, word of the incident would not have reached the surface until the first team members got out. At best, probably two or more additional hours would have been needed for all of the assessment team to return, with increasing concern in camp as more hours passed beyond the scheduled return time. At worst, the additional delay could have made the situation degenerate until a full-scale rescue was required, and the survey perhaps aborted. As it was, the survey team entry was set back a day to let McLean and Swartz recover from their unplanned late-night task.

The survey team (John McLean, Lloyd Swartz, Andrew Grieco, Kevin Glover, and I) finally entered FSC at 8:12 a.m. on July 4. We hiked more than a mile along the ups and downs of the muddy Main Corridor and through the Skyscraper Domes passage to Priority 7 junction, then proceeded to manhandle large packs through the several hundred feet of rocky dug-out crawls and climbs. Several areas there are still disturbingly unstable, and just above the drop rigged with a cable ladder, a 3—by-2-foot rock shifted against Lloyd. He managed to pull away without getting trapped, but the rock settled into a spot where it squeezed the ladder's anchor rope. We used it anyway.

After picking up the radio, which had been left in Priority 7, we reached the low Starry Nights passage with its exceptional starburst gypsum, and came to the junction where the

Photo

Chris Andrews and Steve Lindsey survey into the Metro beyond Snowy River North during the Columbus Day 2003 Expedition.

Photo by Carrie Finn.

fabled Snowy River gallery stretched away north and south. The suspense was somewhat blunted because some of the assessment team the day before had "evaluated" for about 2,000 feet to the south without finding an end, so we knew there was definitely long cave ahead.

The assessment team did help the survey team by determining that the Snowy River calcite pool lining was hard enough and strong enough to walk on without special devices. We accordingly had left behind the "snowshoes," but took in white laboratory clean-room suits supplied by BLM, and "aqua"-type footgear. Before stepping down off the silty bank, while standing on plastic bags and shower-curtain sheeting, we changed into these oversuits, and repacked gear in clean packs or garbage bags. We were ready to start Suunto survey of Snowy River South by about 1 p.m. John and Kevin divided the sketching between them, I took lead tape/backsight and Andrew took rear tape/foresight position, and Lloyd went ahead to set up the radio for communication with the Corcorans and Bilbo on the surface. Lloyd also took many photos with a point-and-shoot digital camera.

THE SURVEY BEGINS

I had been concerned that the pool channel, which we could not leave without getting dirty, might narrow and stay far from the walls, forcing placement of all the survey stations on the floor. In reality, it maintained an average width of 10 to 15 feet, in a sinuous borehole typically 25 feet wide by 15 feet high. The pool channel tended to approach one wall at every bend, and ubiquitous ledges and projections made for ideal station setting and easy sighting. Because of sketching standards, I kept to a maximum distance between stations of 40 to 60 feet; otherwise it might have been possible to have an average shot length of more than 100 feet! John was using a Disto laser range finder for the LRUD data, so the cross-sections were measured, not just estimated. The passage, with an average trend almost due south, remained nearly level and remarkably uniform for about 2,000 feet; the winding conduit reminded me strangely of a lava tube.

At SRS23, we passed a SW-trending side lead, in which a laser shot indicated it was 108 feet to a silt slope in the back. This was much smaller than the main passage, had no calcite on the floor, and had not been flushed of sediment as well as the main route.

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At the intersection was a solution-pocked rock resembling a snapping turtle, so I suggested that this be named Turtle Junction.

The dry pool channel was continuous through the entire passage, being only an inch or two deep in some wide, shallow places, a foot or two deep in most, and at one point deepening to a basin (old plunge pool?) about four feet deep. It was mostly very clean, but specked with occasional small (half-inch or so) bits of brown dirt or stone fallen naturally from above after the pool dried up. The surface was essentially a mammillary crust with knobs composed of smaller clusters of tiny calcite crystals. With clean footgear, we could walk on most parts of it without making noticeable tracks, though the shallow zones close to the margin often had slightly larger porous bumps that would occasionally break if stepped on. The gentle sediment slopes above the pool line were mostly moist silt banks, lightly mud-cracked, soft but not very sticky. The walls were angular, with ledges of thick-bedded limestone and sloping planes of repose, and the ceiling was flattish, scored with crisscrossing joints. Walls and ceiling were mostly coated with a fraction of an inch of brown silt, of which patches had locally fallen away, exposing starkly contrasting whitish, leached limestone. The wall silt itself, up to a height of ten feet or so, was extensively coated with a thin layer of black manganese minerals.

Lloyd set up the radio at three successive stations, and voice communication was successful to surface points along Big Tank Canyon. Owing, however, to a missing end of one plastic arm, the antenna could not be made perfectly square and flat, and attempts to pinpoint spots directly above the cave were believed accurate to only about 50 feet horizontally. Some surface- to-cave depths later e-mailed by John Corcoran:

- Crossing under Big Tank Canyon drainage (SRS14): 120 feet
- Near Radio Station #2: 190 feet [under east edge of valley]
- End of survey at SRS50: 255 feet [under the east flank of a ridge]

After 2,000 feet, beyond the assessment team's limit, the virgin corridor began varying a little more, with breakdown islands splitting the pool trench at a place or two, and the white channel meandering farther to the sides of increasingly wide bends. In a few places, the entire calcite deposit curved under three-foot-high overhangs, forcing us to crawl underneath to avoid walking on silt. This compromised our cleanness slightly, since a couple of the cavers brushed the ceilings, knocking down a few dark bits and smearing the clean-room suits. These suits, which until then had served nicely to keep any dirt from our inner clothing away from Snowy River, began to get some holes scraped into the knees of the Tyvek-type material. Lloyd's suit also split a shoulder seam. The one worn by Kevin, from a different source and appearing to be thin nylon, proved more durable than the others.

Further in, the ceiling dropped slowly, and the passage constricted at SRS48 to 3 by 17 feet. This at first made us fear it might lower to impassable height, but we were encouraged by a steady outward airflow I estimated at 3 to 4 mph (whenever we stood still during the survey, this breeze had been perceptible, even in the largest sections). But the ceiling rose again into another segment of large walkway. The time was then around midnight, and the team decided to make SRS50 our final station, in going cave. Part of this area had manganese on the ceiling, and Andrew suggested the name Starless Night.

Before turning back, however, we scouted ahead probably 150 or 200 feet. On the right, we passed a small south-trending side lead, partly mud-blocked. Then, around a sharp right bend, the corridor came abruptly to a large breakdown room, floored with automobile-sized blocks, with space sloping left and upward into darkness in a roughly SW direction. The white channel followed the right side into a bedrock belly crawl lined to the ceiling with the pool coating. We made this our turnaround point, since we would have had to climb up onto silty boulders to see farther into the room, and we had no way of cleaning ourselves if we did that. I suggested the name Independence Chamber for this room.

We found it easy to walk back to the Starry Nights junction in less than half an hour, where we de-suited and packed up. After some struggles hauling the big packs up the cable ladder and breakdown dome above, we negotiated without incident the part where the rock had earlier slid onto Lloyd, and made good time to Priority 7 junction and then to the entrance. We left the cave after 3 a.m., having spent 19 hours underground. The others in camp had stayed up for us, and the Corcorans had cooked us a much-appreciated spaghetti feast. We were then able to get two or three hours of sleep before the morning heat drove us out of bed. For my own part, every cell in my body felt thoroughly abused the day after. Even strong younger men like Lloyd declare that they never want to do Snowy River trips back-to-back.

FEATURES OF SNOWY RIVER

In going due south, Snowy River South diverges gradually from the SSW trend of the axis of the older part of FSC. I have postulated that passage dissolution in FSC was originally fed by water sinking from paleochannels that are marked by gravel deposits now abandoned and dissected on the ridges above and south of the cave. Input points would have shifted east-to-west as surface piracy cut off successive segments of these channels. It is not unlikely this westward migration of inputs was faster than shifting of the outlet at the north end of the system. The divergence thus far seen is consistent with this model. If it is correct, passages (if any are found) from older inputs farther east may be expected to diverge still further to the SE, giving a palmate dendritic pattern to the system.

John Lyles examines a heavily brecciated South Metro wall. Geologists have much to examine in this new section of Fort Stanton Cave.

Photo by Chris Andrews.

The plot indicates a rise of about 33 feet from start to end of the SRS survey, and an average upward slope of .8 degree. This is consistent with flow from south to north (toward the Rio Bonito). This flow direction is confirmed by ripple marks and other flow lines (some of them calcified and overgrown by the pool deposit where below its level) in the downstream part of Snowy River South. Near floor level, there are also rocks heavily pockmarked by aggressive streamflow, but these hollows were not regular enough for me to read them as directional scallops. On the plotted profile, Snowy River is higher than Snowflake Passage and Sewer Pipe, which (if there is little vertical error in the Priority 7 connecting survey) explains why the muddy floodwaters from the Sewer Pipe conduit have never invaded Snowy River.

At various places along the gallery, banks and bars of stream-laid gravel, with sub-rounded, polished, manganese-coated flattened pebbles, typically up to 3/4 inch long, rise a few inches above the pool deposit. These bars tend to be more pointed to the north, which is also consistent with northward flow. At a few places there are also remnants of allogenic clay, silt, coarse sand and gravel bodies in hollows up to several feet above the present floor. John McLean emphasized to me that the heavy etching and pocketing on breakdown near floor level, even manganese-coated breakdown, supports the idea that the free-surface stream that preceded the Snowy River pool deposit was aggressive surface water.

Snowy River is by far the flattest-floored (and easiest-traversed) passage segment of this length known in FSC. Though most of the cave (with the notable exception of Snowflake Passage) slopes gently north, in profile SNS appears slightly steeper than the overall inclinations of other segments of comparable length in the old cave (as suggested by visually averaging the more irregularly up-and-down survey profiles in the others). This may be because most other passages more nearly follow strike, whereas the divergence of Snowy River puts a slightly greater dip component into the profile.

We encountered almost no flowstone or dripstone along the passage, though there were a bit of flowstone and a ceiling field of closely-set, tiny stub-like stalactites more than 2,000 feet in. A few live water drops were seen in that zone, but the drip rate was imperceptibly slow while we were there. I saw a very little starburst gypsum, far less well-developed than in Starry Night Passage, on the east wall in the downstream part, but no other gypsum of any type. Starburst gypsum, however, may have once been more extensive; near SRS6 (?) I noticed a radiating pattern in wall silt that may be where a former gypsum starburst had been redissolved by wall moisture.

Considering these and previously mentioned features, I interpret the sequence of events in Snowy River South as follows:

(1) Dissolution of a shallow-phreatic passage near the water table by input from a surface stream (with a noncarbonate streambed) to the south (i.e., leakage from a gravel-lined channel flowing from the west from the igneous Sacramento Mountains across the area now perched on Ft. Stanton Mesa).

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(2) Filling of most of the passage with alternating beds of clay- to small- gravel-sized allogenic sediment, during phreatic-to-vadose transition.

(3) Flushing of sediment by free-surface stream flow to present floor level; finer sediments in main channel winnowed out to leave gravel bars and banks.

(4) One or more refloodings to ceiling level, depositing brown mud on walls and ceiling. Mud stalagmites about four inches high, seen on a few ledges just below the ceiling, may have developed as such floods receded.

(5) Deposition of thin manganese-mineral coating over mud and gravel while the passage was mostly filled with quiet manganese-rich water, but not filled quite to ceiling in higher parts.

(6) Cessation of clastic-bearing inflow (because of surface piracy?); drainage followed by localized breakdown, and partial peeling of mud/manganese coatings.

(7) Influx of very slow-moving, calcite-rich water, encrusting Snowy River pool channel.

(8) Drying or cutoff of calcitic-pool source, and complete abandonment by through-flowing water.

John McLean e-mailed an alternative interpretation of the manganese deposition (item 5): "I noticed that the manganese deposits were less dense lower in the passage (nearer the stream level) and wondered if they might not have been formed by migration of the Mn and Fe to the surface of the mud under the influence of capillary forces and evaporation. The greater concentration of Mn at the higher elevations would then be a function of the greater age of the mud—less frequent high stands of the water in the passage."

I saw no historical or paleontological features or cave fauna, or any definite evidence of active microbiological deposition. The manganese-mineral coating, though possibly of microbiological origin and still soft, is probably ancient and inactive, since blocks coated with it have slumped below the pool deposit level and were encrusted with calcite, and no manganese has regrown on the bare wall patches or in the pool basin.

MYSTERIES OF THE SNOWY RIVER POOL DEPOSIT

One of the most puzzling aspects of the Snowy River discovery is its namesake, the Snowy River pool deposit itself. This finely-crystalline mammillary crust clearly grew subaqueously, but it is in some ways unique in my experience. Calcite-lined cave pool basins are most often bounded by rimstone or shelfstone, but in this one, the

white encrustation—which appears to be at least two inches thick in the deeper parts—simply thins out toward the upper margin, ending abruptly at the waterline. Calcite rafts, another relatively common pool-surface feature, are also almost absent here, despite their abundance in nearby Snowflake Passage. (I say "almost" because John McLean did spot a few apparent raft flakes, two to three inches long, along the east shore near SRS6, but these isolated specimens are the only ones seen.)

John Corcoran has raised another troublesome question: how can a basin that held a continuous body of water, that appears to have been so slow- flowing as to be, for practical purposes, a pool, slope at .8 degree over more than half a mile? Systematic survey error would be one explanation, but e- mail consultation with Corcoran and McLean about our techniques revealed nothing that might have caused such an error, and backsight/foresight agreement was generally within one degree. If the slope is genuine, it may be that in the wide, shallow sections there are subtle, gentle rises that are too inconspicuous to stand out as distinct steps. Or it is conceivable that the passage has been tilted measurably northward since it drained; if so, this would suggest an age of at least several million years. Our Suunto survey methods are too imprecise to resolve these issues. Probably the best way would be to conduct a leveling survey with something like a long plastic tube filled with water, in which the level would be identical at each end.

However these difficulties may be explained, it will be very interesting if future explorations can reach the ultimate source of the Snowy River calcite (which could be a highly decorated area). A related question is why decoration with flowstone, dripstone, and gypsum seems to have been so inhibited in Snowy River, even in those few sections where moisture is visible. I would have expected the constant airflow to have favored such growths by enhancing evaporation and CO_2 degassing. It might be informative to measure the CO_2 level in the air of this passage.

SNOWY RIVER SOUTH

AUGUST 30, 2003

On the Labor Day expedition organized by John Corcoran, I was designated as trip leader for continued survey of the Snowy River South borehole, to start where we had left off at SRS50 on July 4. Kevin Glover (U.S. Forest Service, also on the previous trip) was assigned plan sketcher; Barbara Luke (University of Nevada) was cross-section/profile sketcher; Louise Hose (National Cave & Karst Research Institute) was foresight instrument reader, geologist and photographer; and Ed Peyton (one of the Priority 7 diggers) was to assist me with lead tape and scout conditions ahead as needed.

We entered the cave at about 9:30 a.m. August 30 in light rain. Just as we were entering, we were delivered Lloyd Swartz's large roll of heavy white plastic sheeting from which I cut ten strips, a little under three feet wide and 20 feet long, to take in for bridges across floor silt to bypass several places where we had previously crawled into low meanders to avoid walking on dirt. These proved to be very important to the success of the trip, and were useful in more than one way.

It took us about an hour and a half to reach the Priority 7 junction and another two hours to traverse the dig (in which the wind was at first inhaling, but changed soon to blowing out for the rest of the day). We used at least half an hour more to change to clean clothes at the edge of Snowy River. Since we knew that changing back to dirty clothes would be required in the Independence Chamber, we used a new technique to carry the dirty packs while preventing dirt-shedding: white plastic bags of about the right size, slipped over the pack and then slit twice for the pack straps (which had previously been scraped of mud). We then walked the previously surveyed 2700+ feet to the old end station, stopping at the two most problematic meanders to lay some of the plastic strips around them. This worked very well; once someone walked on it, the plastic stuck to the silt enough not to slip, and the bypasses not only protected the pool deposit under the overhangs from further dirt-knocking, but made the travel faster and easier.

THE SURVEY RESUMES

On arriving at the end of past exploration, we first set up a new changing area on a narrow silt flat on the left before the breakdown chamber, laying a shower curtain up the slope as bridge, then placing one of the 20-foot strips at right angles. Then, before changing, we returned to SRS50 and did the four shots necessary to extend the survey the 200 feet we had scouted last time to the start of the chamber.

View up into Lincoln Bathtub Hall from near station SRN80. Snowy River issues from the breakdown at the left.

Photo by John Ganter.

After changing, with the breakdown slope still blocking our view ahead, we were faced with the most suspenseful moment of the trip. I had postulated three possible scenarios in July: (1) terminal breakdown; (2) re-descending to ongoing conduit; (3) hub of multiple passages. We found that an ascent of only 16 feet let us set SRS55 on a rock with a commanding view of the room, whose floor consisted of a chaotic mass of large and small breakdown with loose, porous, muddy earth and chips between. The room was about 75 feet wide and not much more than 100 feet long, trending SW and sloping up to the left, with the ceiling height only 15 feet or so. The Snowy River pool channel had done a U-turn to the right on entering the chamber, then curved left back around the room's lower margin, where many windows and hollows among the breakdown looked down into the white deposit. We did spray shots from SRS55 and 56 to define this edge. As elsewhere along Snowy River, there was no dripstone in this chamber, but some manganese-coated boulders had halo-like ovate patches of thin gypsum coatings.

Scenario 2 proved to be correct. There was neither blockage nor junction; the Independence Chamber narrowed and went back down into an upflow extension of Snowy River, initially relatively low, wide walking passage trending more SSW than the section mapped

in July. We sent Ed ahead to report back whether we would need to change clothes again soon. On return, he called the ongoing passage "gnarly"—still walking height, but lower and rougher than the preceding, with bedrock prongs and lumps projecting from walls and ceiling, and considerable breakdown embedded in the white floor, which split and cut under very low overhangs in many places so that it would be impossible to do a clean walk along the white channel. He was able to get some distance ahead by hopping across channel crossings on rocks, but eventually found that the white became re-centered across much of the floor, and we would have to set a new changing area to re-change to clean mode. Kevin fittingly suggested naming the new passage segment "Return to Snowy River."

Doing the next ten shots, we encountered several places where we had to cross wide segments of white floor that meandered back and forth across the passage. Here we laid down several more of the plastic strips, using them not to walk clean across dirty floor, but to walk dirty across clean floor. They were successful at catching a number of mud lumps that came off our boots. At SRS68 we put down another strip for changing back to clean clothes.

For the next few shots, we were able to stay on clean floor, but still had to thread our way among some large breakdown blocks. Finally these were left behind, and the passage slowly lost its "gnarliness" and resumed a smoother, more symmetrical outline, with white deposit across much of the floor. In this zone, Kevin decided to relax the previous restriction of shot lengths to around 60 feet, and let stations be set up to 100 feet apart. (We later found that the same day's team on Snowy River North had done this too.)

From SRS53 onward, the overall trend of the sinuous passage had been SSW—a noticeable change from the due south of the original Snowy River, and converging slightly toward the Hellhole section of the old cave. At SRS76, however, there was an abrupt turn eastward, after which the gallery turned generally SSE. We had to crawl under an overhang between SRS80-81 to stay on the "river," but it was not as hard to avoid the ceiling as in the ones traversed in July. We kept doing as long shots as possible up to SRS85, when it was after 11 p.m. and the team was tiring significantly. Still no side leads had been encountered. At that point we decided to stop in fine spacious 15-foot-high by 25-foot-wide borehole—the nicest passage yet encountered beyond the Independence Chamber. We gazed longingly on south into the dim distance; the laser range finder said 114 feet to the far wall where it curves out of sight in a slight bend to the right. And still the wind blows!

Since there was no hint that the easy-walking, clean cave would be changing again anywhere close, we saw no need to scout ahead for next time's potential problems, and started back out, going through the complicated clothing changes in reverse. I had had one problem: I had inadvertently left my urine bottle and a quart of water back at the Starry Nights junction, and had found myself at the start of the survey with only a full quart of water. Fortunately, I had brought some gallon plastic freezer bags, and urinated in one of those at the SRS54 changing station. I had to hand carry that from there all the way back to Starry Nights, but was able to get it there and pour it into the bottle without spilling any. Traveling back through Priority 7 was tedious, as usual, but we avoided any rockfalls. We departed the entrance just at 5 a.m., our designated out time, after which John and Dorothy Corcoran served us a much-appreciated spaghetti meal, as in July.

OBSERVATIONS IN RETURN TO SNOWY RIVER

This area had many complicated, contorted chert projections, invariably coated with manganese except where some had subsequently broken. From the ceiling near SRS58, a strange, curved prong about six inches long projected downward, with a 1/4-inch-wide central canal visible at the bottom end where it appeared to have broken across. We were not quite sure whether this was a fossil or a speleothem—probably the former, however. Louise documented this and many other features with several dozen digital photographs.

It would be interesting to know why there have been major breakdown and passage variability in the Independence Chamber and a few hundred feet to either side, but not upflow or downflow. This section is under a high ridge, so the instability is not from valley-floor seepage (and beyond there, SRS85, which plots directly under East Well Canyon, shows no valley influence at all). I suspect some subtle structural disturbance. The westerly bedrock dip appears a few degrees steeper in the Independence Chamber and the "gnarly" passage beyond, which may have something to do with it. The curving of the white channel around the downdip side of the Chamber suggests migration of that segment downdip during the cave dissolution.

There has still been no dripstone found in the extension of Snowy River South, nor any clue to the mysterious source of the white pool deposit, which remains hidden indefinitely further south, to be revealed by later exploration. Small, poorly-developed starburst gypsum has begun to reappear on the walls there.

The Compass program profile plot of the new survey from Independence Chamber inward reveals a visibly slighter slope than the .8 degree of the original part of Snowy River South—virtually horizontal, in fact. (The same is true of Snowy River North from Starry Nights junction downflow.) This raises the question of whether the central segment really slopes .8 degree, or if that indicates a systematic error in one of the inclinometers used on July 4, in which case the entire system may indeed be horizontal enough to have held a continuous pool for nearly two miles (and perhaps much farther)! On the other hand, the slope could still be real. The cave-dissolving water, and later the encrusting water, may have been backed up behind the Independence Chamber collapse, below which the passage steepened slightly to readjust to the lower gradient in Snowy River North. This has some observational support: the "snowy" channel is narrower in the segment that plots steeper, and wider across the floor in the flatter two. I believe the slope discontinuity does rule out the idea that the cave was tilted north since the deposit dried up.

Upflow from Independence Chamber, the average grain size of the clastic floor sediment is somewhat larger than below; sand, often strongly ripple-marked, is frequently to be seen. This is to be expected, as the passage gets closer to the original water source. Fine-grained gravels continue to occur.

The upper margin of the pool deposit upflow from Independence Chamber shows an apparent undulating effect. Close examination shows that this is because the coverage of the little "cauliflower" knobs that make up the mammillary crust is not uniform in the top three inches. In that zone, they grew preferentially from slight discontinuities in the calcified substrate, perhaps slight ripple ridges or truncated bedding planes in the sediment. For two or three inches above the uppermost knobs is a smoothly calcified band of darker color. These relationships are continuous for hundreds of feet.

Observations in Return to Snowy River make possible some refinements in the sequence of speleogenetic events proposed in

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my July 4 report. The entire walls, and also the ceilings at least in lower sections, of the passage upflow from Independence Chamber seem to have been originally coated with black manganese minerals, often with the intricate network pattern of mud vermiculations. Chert outcrops remain almost entirely black-coated, whereas the manganese has peeled from much of the limestone, so that the walls now display an intricate black-and-white pattern. This peeling looks as if it resulted from drying of the walls, but it must have happened before the white floor deposit grew, since no manganese sheets lie upon the existing floor. More likely the manganese was loosened by slight corrosion of the limestone backing before the passage dried out fully, preceding the "snowy" growth.

Finely-laminated clay banks up to two inches deep on some ledges have partially disintegrated, exposing at least four thin manganese bands separated by thicker clay, showing that the manganese deposition took place in more than one episode. The manganese-growing events were evidently of short duration, probably individual flood backups (possibly backflooding from the proto-Rio Bonito valley?). It is clear too that some relatively high-energy flow took place after manganese deposition but before the "snow": some manganese-coated pockets in ledges have fine sand in them, which, if brushed aside, reveals that the manganese was there before the sand. These observations make it even clearer that the manganese coating is ancient and dead, not growing today.

The Compass program compiler shows 2147.5 feet of new survey from SRS50 to SRS85 with an average shot length of 61.4 feet (with the two spray shots excluded).

EXTENDING SNOWY RIVER SOUTH

OCTOBER 11, 2003

For the Columbus Day expedition to Fort Stanton Cave, John Corcoran scheduled three survey days: Oct. 11, Oct. 14, and Oct. 17, with up to two teams permitted for each day. This promised more productive exploration than had been possible with the one-day surveys of the Independence Day and Labor Day expeditions.

For the first survey day, the first team went to the Escalator Passage off Snowy River North, while for the second team, I was designated trip leader and lead tape/backsight man to continue the main Snowy River South trend beyond the Labor Day terminus at SRS85. Kevin Glover was again plan sketcher, Henry Schneiker profile sketcher, Wayne Walker rear tape/foresight, and Jennifer Foote inventory. Our team entered the cave rather late, about 10:30 a.m., but nevertheless ran into the preceding Snowy River North team in Priority 7 because they had been delayed for clearance of some rockfall below Menacing Dome. We all reached the Snowy River "launching ramp" in early afternoon. I had forgotten my clean coveralls, but was able to make do with a shirt borrowed from Wayne Walker.

It took longer than anticipated to reach the end of survey because some plastic-strip "bridges" across clean floor beyond the Independence Chamber, which I mistakenly recalled had been left in place, were gone, and we had to place new ones. We were too late for a scheduled radio to surface contact time at SRS85, but proceeded to survey in mid-afternoon.

The mapping began in some of the largest corridor beyond the Independence Chamber, but the average height of the passage soon began to lower. We had to make many changes of footgear to cross from the Snowy River deposit to silt floor and vice versa. At SRS98, we came to a pinch where a pillar divided the passage into two crawls. Both were traversable; we chose to make the shot through the left, lower-ceilinged one, but ourselves moved through the right one which didn't require being prone. (This may not be a bedrock pillar all the way down; it looks more like a ceiling bulge that extends into the floor sediment.) Beyond, the fork re-united as a crouchway, with occasional standing-height sections, but more low-ceilinged places were soon intermittently encountered, with each successive low segment tending to be lower than the last. The width remained fairly constant at around 20 feet. The passage was sinuous, especially between SRS89 and 93, but the overall direction continued almost due south as before. Despite the lessening height, long shots were still possible; our last two were both more than 100 feet, and the average was 70.2.

We had set an informal goal of getting at least 25 shots, but at station 108, the entire passage lowered to a two-foot-high, 20-foot-wide crawlway. I crawled in about 30 feet, where it rose slightly, but appeared to get at least as low, if not lower, some distance ahead. The next shots would obviously be considerably slower, and it was then already about midnight. The passage was still inhaling a strong breeze, as it had during the entire trip, but we decided to end the survey there, having added 1,615 feet to Snowy River South.

On the east wall near SRS108 was a possible orifice that looked more like a side passage than anything we had seen on that side in the rest of Snowy River South, but it was several feet up a silt slope, and we had left our "dirty" footgear some distance back, so we didn't check it more closely. It was unclear from our position whether it turned or ended; it might either be a passage of up to small-walkway size, or a mud-choked alcove.

Because we had to change footgear so many places (at some of which we left 3-foot plastic squares to facilitate this, but not at all), and often had to move packs and gear by hand through low parts, it took us nearly an hour just to return to our starting point at SRS85. We were all fatigued, and didn't reach the surface until 7:15 a.m., somewhat later than scheduled. The usual, welcome spaghetti feed by the Corcorans and Kat Rix helped revive us.

The features of the extended Snowy River South differed little from earlier-visited sections. Gravel banks and bars reaching above the Snowy River pool deposit were perhaps somewhat more prominent, and the clast size a little larger (often up to one inch); this is consistent with getting closer to the source area. Much of the passage also showed an increasingly noticeable water line about three feet above the white floor deposit, below which most manganese was washed off (evidently by reflooding before the Snowy River white crust developed). This should be favorable to exploring the crawl section ahead, since its ceiling should be mostly in the zone where the manganese is sparse, meaning less black material can be knocked off onto the floor.

Snowy River South passed beneath East Well Canyon without any problem, and the present end is deep beneath the ridge between East Well and Cave Canyon, as far south as the beginning of the Lincoln Caverns section of Fort Stanton Cave. The station SRS108 is now the most remote explored place in the cave, and despite the ease of traversing the

first half of Snowy River South, endurance considerations are becoming significant. Despite the alluring wind, no one proposed resuming the survey there during the rest of the project week. Since the bat-hibernation closure is in effect over the winter, the next expedition is not scheduled until May. Until then, we will be in suspense: will the ceiling squeeze down too low for us to go on without digging; or will it open up again, and in the best possible scenario, break out to a hub branching into a tremendous tangle of galleries?

Probably the best strategy for the next trip is a strong party who leave large packs at the Starry Nights "launching ramp" and traverse SRS with smaller clean rucksacks, no bigger than required for the necessary gear, and light enough to move through many low places by hand. On this trip, I tried Ed Peyton's suggestion of galoshes for crossing muddy ground. It worked well, but they were too bulky to fit inside my rucksack, and having to move a separate galosh bag by hand slowed me too much. I may try just changing to a separate pair of zippered water shoes next time. If it becomes necessary to get dirty above the feet again, a pair of very light but strong nylon coveralls in the rucksack would probably be the best option.

More protective plastic strips could be used at pool-basin crossings in inner Snowy River South. On this expedition, some clear strips were taken in. When laid on silt banks, one can't see bits of dirt dropped on them because of lack of contrast with the substrate. In future, clear plastic should be used only on the white pool deposit, whereas white can be used anywhere.

SURVEYING TURTLE JUNCTION

OCTOBER 14, 2003

On the second survey day of the Columbus Day expedition, the first team continued with the large Metro passage, which had been found on October 11 to go south off the Escalator ascent. For the second team, I was assigned to lead a survey into the side lead at Turtle Junction (off SRS23) in Snowy River South. This lead, named for a snapping-turtle-shaped rock point at the intersection, was the only significant side passage yet found along SRS. It extended visibly southwest for more than 100 feet, but had been bypassed in July and August in favor of continuing the main SRS survey.

A six-person team was selected because two members needed to separate from the party for some time to sample water from Crystal Creek, at the far end of Snowy River North, before returning to the survey. Kevin Glover was sketcher, Ed Peyton did lead tape and backsight, John McLean rear tape, instrument and water sampling, Brian Kendrick photos and Disto passage dimension measurements, I did inventory and some instrument readings, and Kat Rix inventory assistance and water sampling.

Our team reached Snowy River uneventfully, noting that airflow was inhaling moderately in mid-morning in the Priority 7 dig. All changed to clean clothing at the "launching ramp," and after John and Kat separated to do their sub-task, our group proceeded to Turtle Junction. Plastic sheets for changing clothes were placed on the flattest silt area just south of the junction, and the team resumed wearing dirty clothing to start the SRT survey.

The lead started as a walking-height tube wider than high, floored with deep, moist mud patterned with contraction cracks up to three or four inches wide and up to at least 1 1/2 foot deep. The mud was firm but so slick that we had to step along the cracks as footholds to prevent slipping when it was necessary to leave the lowest channel. We stepped around hollows in that channel containing thin deposits of tiny white flakes, evidently rudimentary calcite-raft fragments no larger than about 1/4 inch. These indicated there was once clean standing water in the channel after the mud deposition concluded.

After 100 feet, the passage abruptly lowered to a two-foot-high crawl within a few yards. It looked as if it might end soon in a mud choke, but on entering the crawl, we felt a strong inward breeze. At SRT3 the crawlway turned west, and at SRT4 it opened into a sizable roundish room more than 40 feet wide. Where the eastern end constricted was another windrow of white raft fragments, about four feet long, one foot wide and several inches deep. These appeared to have been concentrated in that spot by an easterly water current or (more likely) easterly airflow over a standing water surface in the room.

At the room's west end, somewhat narrower passage went northwest, ascending several feet up a pitted floor that had been washed clean of mud but had remnants of packed sandy/gravelly fill (small clasts up to about 1/2 inch wide) in hollows. This must have been a steep vadose-stream cascade when water last flowed there.

Beyond, the passage grew more level and mostly mud-floored walkway tube again, winding west, north, northwest, west, and southwest for several hundred feet more. There were several crouchway or crawlway constrictions separating larger halls and chambers. This tributary, rather like the Starry Nights passage but larger, had very few features in common with the main Snowy River corridor. Not only was there no white pool deposit, but the black manganese wall coatings so ubiquitous in Snowy River disappeared within yards of the junction. Mud coatings, often patterned with netlike vermiculations, were still extensive. Many projecting points and bulges were covered with thin patches of calcite crust and fine-crystalline gypsum, with local "starbursts" which, however, were far more weakly developed than the spectacular displays in Starry Nights. Most conspicuous were numerous large areas of small stalactites, up to five inches long, and localized flowstone. There are far more of these in a few hundred feet here than in two miles of Snowy River proper.

We were at about SRT18 when John and Kat rejoined us. Along SRT21-23 the conduit dipped into a paleosump crawl, with deposits of rounded clay bits that appeared as coarse "sand" and small "gravel" in the channel bed. At the upstream end, it opened into a room about 20 feet wide whose right wall was a breakdown flow. A visible waterline ran around this room above the level of the entering crawlway ceiling. Some clay banks on ledges had gypsum needles up to two inches long, the only ones I have seen in the Snowy River extension. To the left at SRT25 was a clean-washed, ascending tube about 4 1/2 feet high by three feet wide—one of the few places in Fort Stanton Cave where I have seen exposed bedrock floor with no fill. Within a few more yards, this split into two crawls, both of which ended against breakdown. The airflow was sucking into this collapse at various points. We could not go farther, and ended survey at SRT29 and 27A, somewhat before midnight, with 1,028 feet.

In pockets along the bedrock floor we found a few curved white pieces, up to two inches long and 1/8 inch thick, that appeared to be old, worn bits of inwashed large-animal bones. Except for some dead tree roots in the Metro, these are the only macrobiological remains yet observed in the entire Snowy River extension. John McLean commented: "The breakdown at the end of the Turtle Jctn. passage was heavily coated (3" +) with mud, indicating that the vadose flow that carved the bare-floored passage was very localized, and that this area, like the rest of lower Snowy River, has been subjected to a long history of back-flooding, presumably when flow events exceed the capacity of the spring orifice(s)."

Our "plan B," if we finished Turtle Junction early, had been to go check leads off the new Metro section south from Snowy River

North, where another team was working. By the time we changed to clean mode and got back to the "launching ramp," however, our energy level was not quite up to traveling several hundred yards, with more clothing changes, and starting a new survey. While several of us did make a quick trip along Snowy River North to see what reaching the Metro junction was like, we soon returned, and departed the cave without incident, reaching the surface before our scheduled out time. Because we weren't expected so soon, we had to wait for the Corcorans' spaghetti to be finished, but it was worth it.

I suggested calling the passage off Turtle Junction the Mudsucker Passage (though others have since referred to it as Mud Turtle, which is more intuitive and perhaps should be settled on). It was apparent the route once had been a drain from someplace in the old cave toward Snowy River, but it wasn't clear to us in the cave just where that connection might be. After John Corcoran had entered our data next day, the end was shown as being close against the east side of Don Sawyer Hall (unfortunately about 30 feet lower).

After viewing the Compass plot colored according to elevation, Lee Skinner suggested the passage leading toward Don Sawyer Hall from the west (ca. A76-A82), which lines up nicely with the Mud Turtle Passage, is the upflow end of the same conduit, interrupted by the Sawyer Hall collapse. I visited that passage three days later to evaluate his idea. I concluded it might well be correct. The A76-A82 segment is a mud-floored tube close to the size and appearance of Mud Turtle, with a flat floor channel of comparable size (though lacking mud cracks and the varied decorations of Mud Turtle). It is at about the same elevation, and the survey indicates a slight downward inclination to the east (though this may not represent the true floor slope).

Mud Turtle's close approach to Don Sawyer Hall is thus far the only place except the Priority 7/Snowflake #3 breakdown where there is any indication of connection of the Snowy River section with the original Fort Stanton Cave. If the link could be made traversable, it would be a much faster, easier, safer route into Snowy River. Unfortunately, there is no visible hint from the Don Sawyer side that the hidden drain exists, and opening a passable route between the two would apparently involve moving large breakdown for at least 30 vertical feet. But if Snowy River keeps extending indefinitely, such a dig is worth serious consideration. Meanwhile, it would be good to confirm the exact relationship between the two by radiolocation.

It was puzzling that the airflow during our trip had been eastward through Priority 7, but westward into Mud Turtle. I would have expected both passages to blow the same way between the old cave and Snowy River at a given time. Possibly there was a reversal between our departure from Priority 7 and our entry into Mud Turtle. I took a temperature reading of 56 degrees F. near the end of Mud Turtle, which agreed with one earlier read in Priority 7, but contrasted with 58 degrees in inner Snowy River South. (The latter, as might be expected, seems to be more remote from surface cold-air input.)

THE METRO MOP-UP SURVEY

OCTOBER 17, 2003

For the final survey day of the Columbus Day expedition, there were only six people left who were prepared to do a Snowy River trip, so only one team went in. Lloyd Swartz was appointed trip leader and lead tape for a check of some unfinished leads in the first half of the Metro passage that forks southward from Snowy River North at SRN13. Chris Andrews was to do the plan sketch, John McLean the section sketches, Jim Lawton one instrument position, Steve Lindsley rear tape and photo, and I inventory. Our trip into the cave was routine, and in due course we arrived at the "launching ramp," changed to clean clothes for the short crawl and walk along Snowy River North, changed back at the departure point, and struggled up the impressive Escalator scree slope that led up to the Metro passage proper, some 70 feet above Snowy River.

Chris and Lloyd had been on the previous Metro surveys on October 11 and 14, and had found it to be a large undulating borehole going predominantly south, parallel to the first part of Snowy River South, before ending at a massive breakdown. They had left a large descending lead forking south from the "Roundhouse" junction in a wide room at 1SRN11; this was chosen as our first objective. I noticed that the wall of bedded limestone between the upper left and lower right passage orifices had an unusually steep westward dip (ca. 20 degrees), which suggests a structural deformation that might have something to do with the branching of the cave at this point. We started the RH survey here.

The first shot descended southward at 18 degrees for 78 feet, after which the passage leveled off and grew smaller. Beyond RH4 was a fork; I scouted the right branch for about 50 feet, but it was crawly and we left it in favor of the left one. That pinched to a belly crawl for a few feet, then became a good-sized walkway again, with an angular cross-section. The central part had a ceiling window to 1SRN above; our passage there proved to be the bottom of the "Scary Carry" slot which had required a ledge traverse during the original survey of the upper level. RH had initially been rather barren of decoration, but as we went on, increasingly large and thick patches of gypsum crust appeared, and small flowers. Along RH12-14 there was intermittent crust up to two inches thick, and small, very delicate gypsum flowers. Some of these were nearly hair-thin and up to three inches long, perhaps the most slender gypsum flowers I have seen anywhere. Beyond RH14 our passage rejoined the Metro at 1SRN22. The RH survey totaled 734 feet.

Although there were a few modest west-trending leads along this part of the Metro, we elected instead to try extending the North Metro, a smaller northward-going extension previously mapped from 1SRN10, whose last shot to 1SRN24 had been plotted as crossing the Snowy River North borehole below—a unique occurrence in Fort Stanton Cave. After returning to 1SRN10 via the spacious upper-level Metro, we traversed the previously surveyed North Metro horizontal walking and crawling conduit, crossing interesting dry mud-cracked silt floors, to the last station, then did one more 34-foot shot in a wide, flat two-foot-high continuation. Unfortunately, it was clear that the passage became too low within the next 30 feet. Lloyd checked a partly separated space to the right, which also ended. We didn't notice definite airflow.

Then, rather than go back through the Metro to other leads which the original explorers didn't seem to regard too highly, we decided to go back down to Snowy River North and survey into the first of the several "windows" along the northwest side of SRN. After another set of clothing changes, we climbed up the steep mud slope above SRN7 into a large borehole segment that proved to parallel SRN northeast before dropping back into it. We tied back to SRN12 in five shots. The most interesting feature of this balcony was numerous splash pits, up to two feet deep, in the old mud floor. None of the drips seemed currently active. We then made one steep 80-foot shot southwest up a massive angle-of-repose breakdown flow that may be the Snowy River side of the Snowflake #3 collapse. I poked around where the breakdown met the ceiling, but found no penetrable routes, though the edges of a few blocks had fringes of tiny coralloids like incipient atmospheric rims, suggesting possible interaction between internal and external airflow. We

flagged our stations as W1-5 in the cave, but because there is a previous W survey of which we were unaware, they have been entered in the computer files as WN. This survey includes 324 feet.

We were now up to 1,092 feet of survey for the day. We briefly discussed going farther into SRN to try more windows, but we were tiring enough to find the repeated clothes changing increasingly challenging, and the next windows were thought to be more difficult to reach. We thereupon decided to leave the cave, which was done uneventfully and ahead of schedule. Jim Lawton and I made a 45-minute detour to Don Sawyer Hall as mentioned above. Rather than spaghetti this morning, the Corcorans and Kat Rix fed us beef stew, which was equally welcome.

METRO OBSERVATIONS

The Metro borehole is surprisingly different in many ways from the closely parallel Snowy River. It appears much older, has well-developed dripstone, flowstone, and gypsum, and its sediments are so dried and shattered that in most of the conduit they appear to show no definitive indicators of flow direction. John Lyles, however, commented: "...I believe that we saw definite channeling and flow ripples in the ancient stream segment we found near (1SRN70??). Also, a low channel cut under the east wall and looked like a drain—too tight to crawl into and no air. It looked to me like the flow had come from S to N. This very interesting intact stream segment should be looked at next trip, by a science type. It is unlike the rest of Metro."

Perhaps most interesting, the Metro borehole undulates up and down for more than 100 vertical feet. The reason for this has not heretofore been clear. I was thus gratified to see a strongly relevant piece of evidence. The ceiling of the higher level of the Metro, at least between about 1SRN10 and 1SRN30, is formed by a bed of brown breccia with an impermeable-looking siltstone matrix, in sharp contact with underlying bedded limestone. The passage cross-section arches four or five feet up into this probably largely insoluble material, and the passage, at least in this segment, curves up and down following this contact closely. It looks as if the conduit originated in the phreatic zone, and the insoluble layer formed a caprock, which forced the conduit to weave up and down while the water table remained above the siltstone. Our underlying RH survey may be a slightly later horizontal vadose bypass developed between sumps after the water table descended below the highest part of the siltstone contact. It is not clear what this conduit did as it descended to the north; the connections to Snowy River North are complex, but it may have been linked with the segments between the "windows."

Lewis Land raised the question, in his report reproduced in the July expedition CD-ROM, of whether the bedrock breccias in Fort Stanton Cave were originally developed as paleocave fillings, or are a phenomenon of broader areal extent. My preliminary observations of the relatively wide contact in the upper Metro suggest the latter. (Supporting comment from John McLean: "The breccia layer in the Metro is clearly depositional in the San Andres, because there are stray siltstone layers below the top of the underlying limestone, and because the underlying limestone is a silty marl for the first 2-3 feet below the contact. Both the clasts and the matrix in the breccia predominantly are poorly to moderately consolidated siltstone.") Mapping this contact over the full length of the Metro should be a high-priority goal on the next scientific trip.

A group begins the climb of the steep, rocky slope of Disappointment Dome near station 1SRN82.

Photo by John Ganter.

It is interesting that the terminal breakdown of the South Metro is within a few hundred feet of the breakdown that created the Independence Chamber along Snowy River South (which, fortunately, was not terminal). It may be that both of these collapses resulted from the same structural anomaly.

The three-day rests after the first two survey trip days seemed to rejuvenate those of us who were making trips on all three days, but most of us felt that we tired earlier on each successive trip than we had on the one three days before. I, at least, was quite wobbly on the walks through the Main Corridor when departing the October 14 and 17 trips. It may be that even three days is not long enough for complete recovery. It is therefore probably best to schedule the hardest trips for the first day of future expeditions if the same personnel are repeating, or send in completely fresh teams if particularly hard trips are to be scheduled at short intervals.

The Crystal Creek end of Snowy River is still closed because of BLM restrictions on entering water, Mud Turtle and the South Metro borehole have ended in breakdown, and remaining leads off the Metro are small. Snowy River South—despite its disturbingly low ceiling—seems to be the best immediate hope for continued major extension of Fort Stanton Cave. The airflow direction reversals do not seem to correlate well with diurnal temperature changes, and it begins to look increasingly as if the wind may be barometric. This would be unusual for such an epigenic cave, where multiple entrances and chimney-effect winds would be more normal, but if true, there must still be an enormous volume of unknown cave beyond Snowy River South.

EPILOGUE

There is a significant problem with the survey; the southern part of the Metro, between 1SRN56 and 63, plots as intersecting and crossing Snowy River South between SRS27 and 30! There is actually no sign of connection between them in the cave, and it seems highly unlikely that either passage crosses under or over the other. This spurious loop is several thousand feet long, and even a 1% inaccuracy of the survey might account for the discrepancy. However, there may be more involved than random error. I wonder whether the siltstone caprock over part of the Metro might contain enough magnetic iron to cause significant divergence from magnetic north. Radiolocation is planned to try to resolve the true relations between the passages.

I have given some thought to the difference between the vertically-undulating Metro and the closely-parallel but very flat Snowy River South. The Metro seems to have been the older conduit, developed phreatically when the water table was at least 100 feet higher

than when Snowy River was enlarging, but with segments curving as deep as the Snowy River level. As the water table dropped, bypasses of the upper curves would have tended to develop. Initially, these would simply have been free-surface stream segments lower along the Metro trend itself, such as the RH survey appears to have been: air-bell stream sections between sumps. However, as more pressure head developed from the water-filled conduit toward the descending water table level around it, the entire flow of the Metro may have been diverted to the Snowy River course slightly downdip; that is, Snowy River pirated the Metro at a point beyond current end of survey. If so, future exploration in Snowy River South may intersect an extension of the larger Metro conduit beyond the Metro breakdown, providing a bypass of the present Metro terminus.

In September, Victor Polyak, of the University of New Mexico, announced a uranium-series date for a sample of some of the youngest calcite in the Snowy River deposit. It was startlingly young—only 152 +/- 61 years! This suggests to me an explanation for the oddities of the Snowy River deposit. Perhaps it is dry now not because it is ancient and permanently abandoned, but because it fills intermittently. During wet times, it may fill to a spillover point whose level is marked by the top edge of the deposit. But as inflow declines below the rate required to overflow, evaporation and seepage will make the level drop. Thus the deeper parts of the channel will hold water longer, but it will never stabilize for long at any one level. This is probably why no rimstone or shelfstone can develop, and the calcite is progressively thicker below its upper limit. Intermittency also implies that Snowy River may reflood in the future, so it will be well if the exploration can be completed while it remains dry, before the next wet climatic cycle.

Because I was not on the Snowy River North surveys, I have said little about that valleyward end of the breakthrough. It trends NE, directly toward Government Spring in the Bonito Valley. It is larger passage than Snowy River South, apparently because it incorporates the additional volume of the Metro after the two join. Exploration ended where it dropped off a ledge and a small stream, named Crystal Creek, appeared below. BLM has suspended its further exploration pending results of microbiological analysis of water sampled in October. The stream will presumably flow into a sump before reaching Government Spring, the probable outlet, still several hundred yards away. This will not necessarily end the passage—paleopassage may continue past the present outlet toward an older one farther downvalley, or another southern tributary like the Metro may come in before the end.

Unfortunately, our return in May has been cancelled, and there will apparently be an indefinite but long delay in discovering more of Snowy River. In March 2004, BLM issued a memo announcing that they are locking Priority 7 to further entry until it is either enlarged and shored, or the Mud Turtle bypass is dug open. The latter will be difficult to do without at least one more trip into Snowy River to radiolocate the connection point in Sawyer Hall with more certainty. Either option may take more than a year to complete.

This article is based on reports to the FSC Project and BLM; portions originally appeared in ***Southwestern Cavers.*** ■