CASTLEGUARD CAVE DIGITAL MAPPING – VOLUNTEERISM OVER FOUR DECADES

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Abstract

Though known since the 1920s, Canada's longest (20 km) and arguable most famous cave, Castleguard, was only extensively explored starting in 1967. These initial explorers were part of the McMaster University karst research group. Continuing on to the present, cavers from across Canada and around the world have participated in the exploration, study, and mapping of this international caliber resource located in Banff National Park. It is the only known cave under an icefield that has passages blocked by glacial ice extruding into it.

The production of a large scale map had often been talked about but never realized until recently. Parks Canada went to the public source best able to provide the expertise, the Alberta Speleological Society. Encouragement was given towards pulling together the vast amounts of survey data for the goal of the large-scale map.

By November 2004, Dan Green of the Alberta Speleological Society, was ready to release the first large scale and digital map of the cave. It consists of two versions; a set of six map sheets 1 by 2 meters and a set of 56 field sheets 8.5 by 11 inches in size.

In March 2005 Dan (ASS) and Greg Horne (Parks Canada) lead a volunteer group of five cavers (members of Alberta and British Columbia speleological societies) to start to use the base map for the purposes adding missing information, correcting errors, and inventoring of cave resources. Five days were spent underground camped about 5 kilometers into the cave. The trip expectations were well met. Future volunteer visits to continue the collection of information are possible.

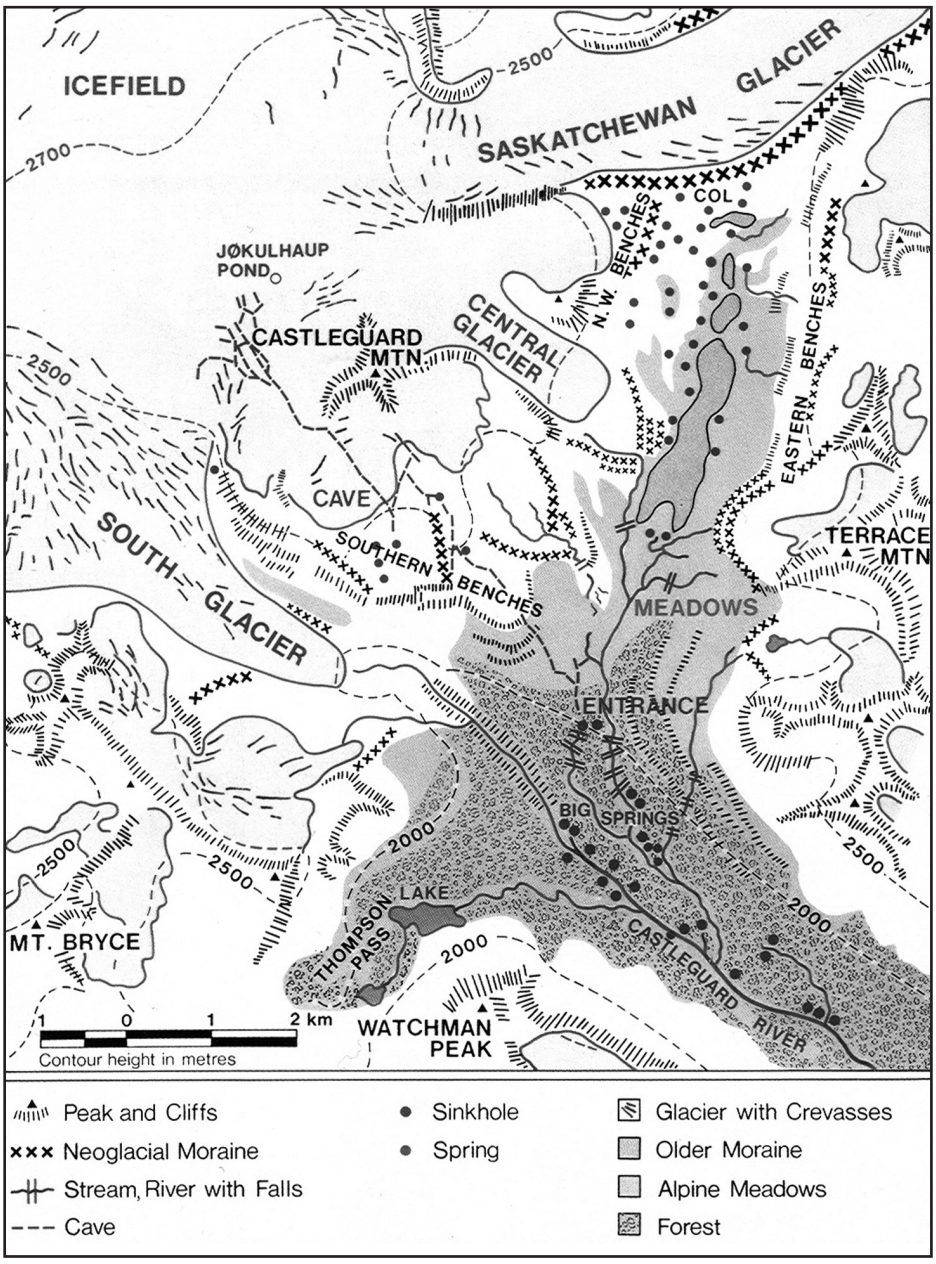
Although this type of cooperative cave exploration, survey, and map drafting project is common in other countries. It is the first time a project of this magnitude has occurred with Parks Canada.

Setting

Castleguard Cave is located in the northwest corner of Banff National Park, Alberta, Canada. The single entrance is situated just below the treeline. In summer, periodic resurging glacial flood waters issue from the cave. It is the only known cave under an icefield that has passages blocked by glacial ice extruding into it.

Background

Although discovered in 1921, an 8-meter vertical drop near the entrance barred further access until cavers from McMaster University karst research group descended the pitch and began the serious exploration of the cave. By the late 1980s the exploration and survey drive had nearly ceased. Twenty kilometers had been recorded. The very linear character of the passage layout and narrow nature



The Castlegard area.

The Project

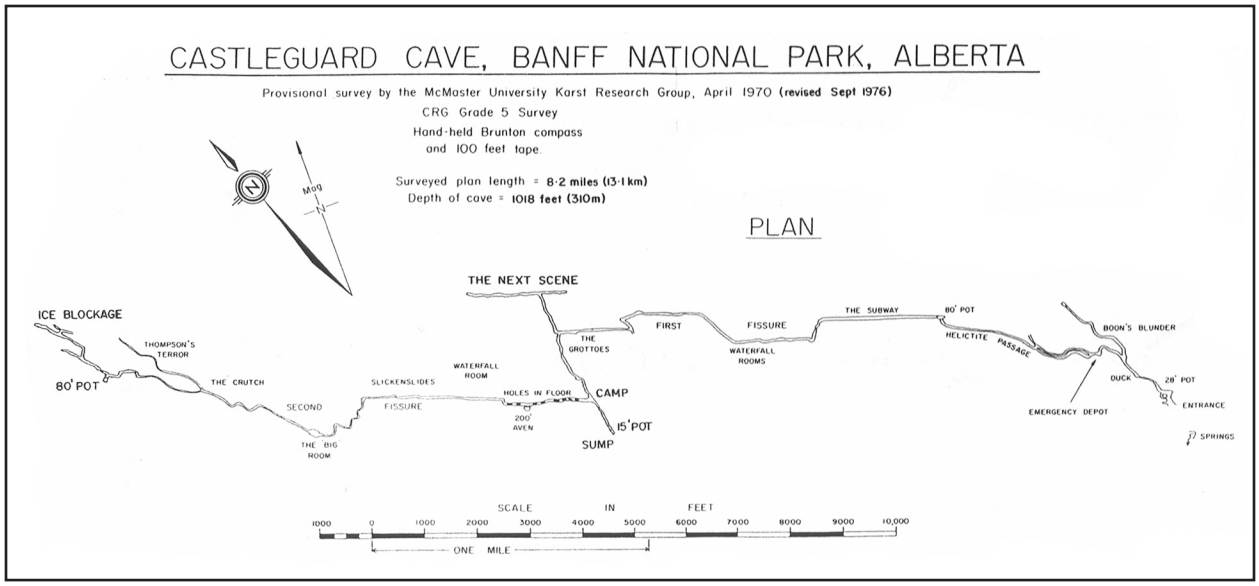
The obvious need to assemble, refine, and present decades of survey data information collected in the cave was realized by Parks Canada. Part of that process would be the production of a large-scale map that would be the basic framework to which all other components could be related. With no base map, how could resource inventory, impact mapping, or exploration potential proceed?

Parks Canada went to the public source best able to provide the expertise, the Alberta Speleological Society. Given the past history of misunderstanding and mistrust, a slow relationship building process began. It involved sharing of information, participating in cave exploration, survey, and restoration activities together. As time passed I gave encouragement towards pulling together the vast amounts of survey data towards the goal of the large-scale map. Alberta Speleological Society member Taco van Ieperen, computer programmer by profession, took the plunge and began the daunting process.

Another society member, Dan Green, learned of the map project. His past participation in major cave mapping projects in Mexico and being a design professional drew him to volunteer his time to transform Taco's very important computer data input and sketching efforts into a base digital map. He used the computer program Adobe Illustrator

of the cave passages did not encourage the need for a large scale map. A line plot represented the cave very well when presented at 11 by 17 inches.

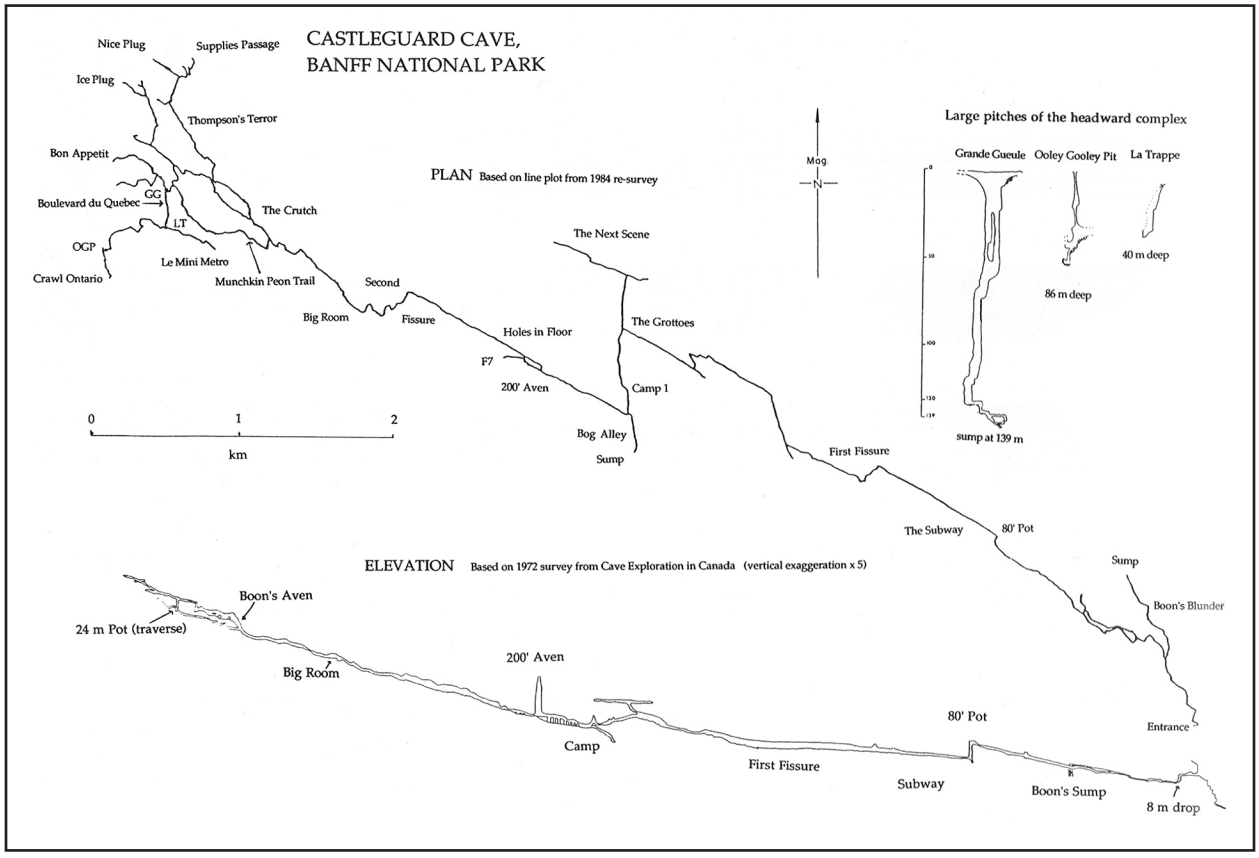
Though often talked about, a large scale map had never been drafted. The entrance to back-of-the-cave straight line distance is about 5.5 kilometers. A map at the scale of 1:1,000 would be 5.5 meters long. If produced, where and how could it be viewed? Advances in digital mapping that are possible from a home computer made the final map scale much less significant an issue.



The Castleguard Cave map in1976.

in conjunction with the cave survey program Walls. This process was more than two years of work in the evenings and days off. There were major computer heartburn hiccups along the way. Continued dialogue, suggestions, and moral support by me kept Dan progressing forward.

Then, in November 2004, Dan was ready to release the first large-scale map and digital map of the cave. It consists of two versions; a set of six-map sheets 1 by 2 meters and a set of 56 field sheets 8.5



The 1984 line plot of Castleguard Cave.

by 11 inches in size. The field sheets would be the format to be taken into the cave.

In March 2005, Dan and I lead a volunteer group of five cavers (members of Alberta and British Columbia speleological societies) to start to use the base map for the purposes adding missing information, correcting errors, and inventorying cave resources. We spent five days underground camped about 5 kilometers into the cave. Our trip expectations were well met. Numerous future volunteer visits to continue this process are possible.

This volunteer project highlights the possibility of forming a partnership between a special interest user group and Parks Canada for the purposes natural resource discovery, inventory and therefore better resource management. The special interest and skills required for many aspects of this project plus its scope necessitated participation of the public. In total more than 50 people have donated thousands of volunteer hours from 1967 to present to bring the map to its current state. Continued communication and interaction between user and land manager are required to maintain this mutually beneficial relationship.

The continuation of this article is by Dan Green.
Dan's perseverance and determination resulted in a map product that will serve this generation's and next's Castleguard users.

The Castleguard Map

Digital Mapping using Walls and Adobe Illustrator 10

In the late 1990s Taco van Ieperen of Calgary compiled 30 years of survey data, sketches, and partial maps for Alberta's Castleguard Cave and generated a monumental pencil sketch on 60 letter-sized sheets of paper. His groundwork inspired the final digital inking. A digitally finished map makes sense for such a large cave because it allows a combination of artwork, survey data, and other information to exist in different layers within one master file. Digital maps are easy and cheap to store on hard drives or CDs, and they allow simplified distribution and updating.

The basic steps for making cave maps remained unchanged since the early years but recent software has improved data management and common vector drawing programs are ideal for digitally inking a cave map. With traditional survey notes, the basic steps for producing a cave map start with organizing the data and getting a line plot, then drawing a pencil sketch over the line plot and finally "inking" a finished drawing. I initially saw my role as completing the finished drawing but getting there involved a total reorganization of the survey data that in turn meant restructuring the artwork to match.

Vancouver caver friend and GIS administrator Tyson Haverkort supported my concept idea of creating this master file and helped me launch the project with Parks Canada through Jasper Park caving warden Greg Horne in 2001. The major steps for getting the project from pencil sketch to a series of both large wall maps and smaller field maps included:

- Converting the pencil sketch to images manageable on the screen.
- Reworking the data from OnStation into WALLs to get the line plot.
- Arranging the digitized sketches over the line plot.
- Building a library of symbols and lines and inking the artwork.
- Rebuild the WALLS data with newfound data and invoking magnetic declination for true line plot.
- Restructuring the artwork to match the updated line plot and completing the master file
- Producing wall maps and field maps from the master file

Pencil Sketch: From Paper to Screen

The pencil sketch was drawn on letter-sized sheets, taped together in blocks, and these had to be digitized into manageable screen-friendly images. We taped the 57 pencil sketch sheets together on top a large piece of pattern paper a meter wide by eight meters long. Tyson managed to have this scanned on a wide-format scanner. Amazingly he e-mailed this to me as a mysteriously compressed TIFF that was only 1.3 mbytes. But it was only readable in AutoCAD, a program I didn't understand at all. I wanted to work in a familiar vector drawing program. Trying to open the file would crash most computers, so for a while the project took a back seat to others. In March 2003 Vancouver Island caver Craig Wagnell and Indiana caver Aaron Addison proved the file workable. Craig managed to open the scan and reduce it to manageable bits. His computer had taken a while to open the file, but had managed to unzip the 1.3 mbyte scan to 2,000 mbytes. He sent me 75 small files in different formats (PDF, JPEG, TIFF, PSD, AI), exactly what I needed to begin puzzling it back together on the screen. This would lay the foundation for digital "tracing."

Line Plot: OnStation to WALLS

A true line plot was needed as the first layer for the digital inking in Illustrator. This is the foundation that the sketches and entire map would be arranged over. The pencil sketch was made over a line plot but was fragmented on many taped together sheets sure to have misalignment error. The Castleguard survey data was in a very rough OnStation file converted from SMAPS. Most of the data was grouped together in logical regions of the cave, but nothing was labeled and there were no keys; much time was spent figuring out which survey legs were which, and where they were. A large chunk of the data was in feet and tenths of feet that I converted to meters with Excel. I began rearranging the survey data in WALLS survey management

software. WALLS is regularly updated software by David McKenzie in Austin and includes features like the International Geomagnetic Reference Field (IGRF, a mathematical model of Earth's magnetic field and annual rate of change) and Scaleable Vector Graphic (SVG) options that integrate the data and artwork with Adobe Illustrator to integrate and reflect updated survey changes and additions. Eventually the data was regrouped into general areas of the cave, nothing too specific, and redundant data deleted, but unknown data was missing that I decided to track down later. I exported the line plot with stations names and a grid from WALLS as a Windows metafile and imported this into Illustrator to begin placing the JPEG sketch files above it. Big mistake. I should have spent more time tracking down the missing data and making sure it was perfect and up to date. This would delay the project for more than half a year.

Pre-Inking: Arranging Digitized Sketches Over the Line Plot

By this time I'd replaced the PC and AutoCAD with a G4 iMac and Adobe Illustrator 10. I chose to use the 20 sub-1 mbyte JPEG files that puzzled together to make the entire cave, and lay them over the digital line plot to ensure both matched. Not surprisingly the line plot and artwork didn't precisely match up, but I'd been expecting to cut and paste the artwork to match so basically just arranged the sketches as best I could in their own layer. Illustrator allows any object to be made transparent, this allowed the line plot to easily show through and the sketches could be overlapped without blocking one another. Since we were shooting for a 1:1,000 scale, this meant the map would be over 6 meters long. Illustrator's artboard maxes out at 5.8 meters, so I instead worked the map in three different files. This was also useful for keeping the file sizes smaller as I would need to keep the larger-sized JPEGs I was tracing over as a layer until I was sure they could be removed.

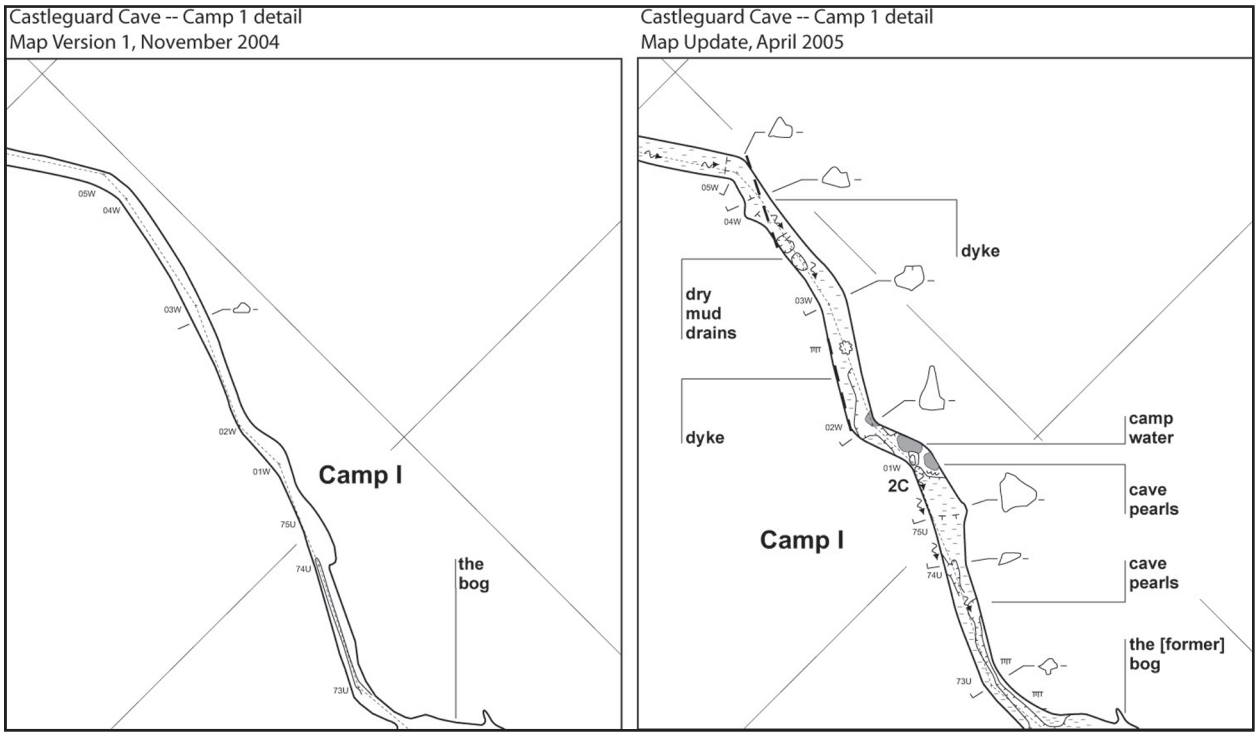
Library of Symbols and Detailing: Elements of the Artwork

I developed a library of symbols and line weights and rules to work with. specific line weights suited the walls and others suited floor detail. A specific format was designed for the many cross sections. I developed many rocks of different sizes and shapes, as well as stylized symbols for bedrock, mud, stones, and the like. Instead of diagonal lines and crosses I used fills along the grayscale for water and a customized fill indicating seasonal ice. With a complete library of standardized detail objects it's easy to copy them into the drawing later on.

Vector drawing programs like Illustrator let you create layers to organize different elements of the map. Each of these layers can be locked to prevent accidental selection, and each layer can be made visible or hidden with a click of the mouse. For example, I imported the line plot (complete with grid, survey stations and survey station markers) into one layer I called LINE PLOT and locked it. In another layer called SKETCHES I assembled all the scanned JPEGs to overlay the line plot, and then made them slightly transparent to allow the line plot to show through, then locked it also. I created a layer for the WALLS and began to "trace" the walls of Taco's sketch. Rather than trying to maintain a steady hand, Illustrator offers a pen tool where a click on the screen activates a line and another click anywhere draws the line between. The line can be curved and smoothed as you go or be adjusted anytime later with infinite control points. This method was essentially the same for drawing all the floor detail and cross sections. Dan Pach suggested using a combination of leader lines, simple font and multiple heading levels for the large amounts of type on the map. I completed the first draft of the master file by November 2003 and sent a copy to the Alberta Speleological Society AGM in Edmonton for review. Greg Horne coordinated the review as it was edited by Castleguard veterans Julian Coward in Edmonton, Ian Drummond and Ian McKenzie in Calgary, and then finally Chas Yonge in Canmore.

Rebuild Data: Magnetically Adjusted Line Plot

In the meantime I began rebuilding the survey file properly in WALLS, reorganizing files, first by year and then cave region and survey date. There were about 500 meters of slowly-emerging survey data missing or disconnected by sequence. I also invoked the magnetic declination calculator within WALLS that would adjust each individual survey



Camp 1 detail in version 1 as of November 2004 and after the April 2005 map update.

relative to true north, rather than to magnetic north that misaligns them relative to one another. Magnetic north has deviated roughly 4 degrees from when Julian Coward and Peter Thompson surveyed the Ice Plug in 1970 to the most recent 2005 Parallel Universe survey beneath Holes-in-the-Floor; without adjusting for magnetic deviation the line plots are thrown wildly off. By fixing the entrance station on earth with lat/long/elevation and assigning a date directive to each individual survey, WALLS produced the first accurate line plot of the cave. But this instantly threw the already completed artwork off significantly from the line plot upon which it was already built.

Final Edit: Update and Rebuild Master File

Working 100 meters at a time, I split apart the artwork and spliced it back together over the improved line plot. The final master map has many layers, any of which can be "turned off" to be invisible or locked to prevent changes. For example, it's easy to see and print the maps without any survey data by turning off the layers called Line Plot, Station names, and Station markers. Additional layers could be added at any time (colored water and words, a fauna layer, a topographical layer, a photo layer, and so on). Steve Worthington, who knows the cave well, became involved in the summer of 2004 and did the final edit on the map. He reviewed the survey data (many of the number/letter sequences he had assigned years ago) and came up with the remaining missing data.

Map Series: Generating Field Maps and Wall Maps

With the master complete I extracted both a Field map series and a Wall map series. The Field map comprises 56 letter-sized sheets and there are six tiled Wall maps. To maintain the layers format the master file was duplicated 56 times and everything but the artwork for each specific sheet was deleted. The remaining artwork was fitted into a frame and legend template and saved as its own map. The files were exported as relatively small PDFs and can be e-mailed or stored easily on hard drives or CDs (for example, the Field maps are only 6 mbytes and the Wall maps are about 500 kbytes each).

The field maps were used in Castleguard in 2005. A team spent four days at Camp 1 mapping missing passage detail in Next Scene, F7, and the

Grottoes, as well as studying isopods and checking unmapped leads. The maps worked well with the additional of the raw survey data cut and pasted onto each sheet — a new layer to be included on the next update. All updates to the map are done on the master, and affected map sheets are generated from that.

In recent years newer software emerged to allow cave maps to exist as dynamic projects created, updated, and viewed digitally, where hard copies would be only current snapshots. Using WALLS and Illustrator, Scaleable Vector Graphic (SVG) round-tripping makes it possible to link both the survey data and artwork together so that changes to the data (resurvey, new loops, and so on) are reflected accurately in the morphed artwork. This literally marries the survey data to the map. Some current cave projects have been using digital alternatives to the traditional process for map making. Instead of considering surveying and sketching the independent precursor for map artwork, some projects are recording the in-cave survey and sketch digitally which produces a scaled digital rough draft right in the cave. Some of these developments may be the next logical step for managing Castleguard as an ongoing project. There are many areas of the cave that lack adequate map information, good prospects for future trips. There remain over 40 unmapped leads.

Much thanks to Greg Horne and Parks Canada, The Alberta Speleological Society, Tyson Haverkort, Craig Wagnell, Aaron Addison, Dan Pach, Julian Coward, Ian Drummond, Ian McKenzie, Chas Yonge, Steve Worthington, and Taco van Ieperen.