SURVEY AND MAPPING TECHNIQUES AT CHILLAGOE, NTH. QUEENSLAND

Neil I. Smith

Abstract

Some characteristics of the Chillagoe Caves in North Queensland are briefly described and a short history is given of the types of survey and mapping work performed. "Perimeter Surveys" around the karst towers are important contributions to speleology in the area. The reasons for this are discussed, and some work done in 1983 using theodolite techniques is described. A worthwhile improvement in accuracy has been achieved. Some examples of recent maps are included.

CHILLAGOE CAVE TYPES

Chillagoe in Far North Queensland is an area of seasonally arid tower karst. The limestone towers, which number in the hundreds, range in height (relative to surrounding topography) from 10m to perhaps 100m. Solutional weathering has reached such an advanced stage that their upper surfaces are an alternation of knife-edged ridges and deep grikes, most of which lead to cave systems of greater or lesser extent.

The towers are in fact so "hollow" that in cases where exploration has been reasonably thorough, the overall plan view maps of the towers show virtually no substantial limestone areas devoid of underground passage. Examples are the Queenslander Tower (CH5246), Walkunder South Tower ((CH5170) and Con Tower (CH5160). Most other towers have been explored less thoroughly than these and it is likely that they will prove equally cavernous.

The forms exhibited by the cave passages are quite diverse. One common type has a flat floor of mud infill and very high (10-40m) smooth rock walls usually becoming closer together towards the top. These passages often underly linear grikes on the surface and frequently connect with them, so that "daylight" holes are common. Such passages (and grikes) are apparently formed along the joints in the limestone and "silhouette" style cave maps of entire towers usually show a large degree of parallelism in the passage system. In many cases "false floors" of consolidated and calcified infill material remain suspended at various levels in these enlarged joints making superimposed passage systems common.

A second common occurrence is the phreatic solution tube. These types are often almost circular in cross-section, ranging in diameter from 10mm to 3m, and may be included horizontally, vertically and obliquely. Some extensive "Swiss Cheese" mazes are known. Connections between major passages and chambers and indeed between caves previously thought separate are frequently made by "pushing" the smaller types (not the 10mm ones!) and by exploring upper levels on false floors.

AIMS OF MAPPING

Given the nature of the predominant cave types, it is not a particularly satisfying exercise to draw maps of individual caves. Such maps often become out of date because new "connections" to other known caves are made so frequently. Rather, the TOWER is the logical unit for mapping, for a number of reaons:

(a) Underground connections BETWEEN towers are unknown.
(b) ACCURATE whole-tower maps can provide valuable information about where to look for possible connections between caves (e.g. where passages approach closest, or where two passages are collinear and obviously enlargements of the SAME joint).
(c) These same maps lay bare the joint structure of the limestone, a matter of some geological interest.
(d) A new cave entrance find can be readily documented by way of a grid reference on an existing tower map.
(e) Interesting features EXTERNAL to caves can be represented on whole-tower maps, for example cliffs, pinnacles, Aboriginal painting sites and roosts of the Black Flying Fox (*Pteropus alecto*).

However, towers frequently are 1 to 4km in linear dimensions and the scale of the whole-tower map usually too small to show cave passage detail. Larger scale maps are also required and it is convenient to organise these in modular or "street-directory" fashion with sheet boundaries corresponding to round-figure grid lines on the tower map. At Chillagoe the grid is of necessity based on a local datum but an effort has been made to correspond with the Australian Map Grid (AMG) as closely as possible.

HISTORY OF MAPPING IN CHILLAGOE

A few cave maps were produced by members of Sydney Speleological Society as a result of trips in 1967 and 1969. It was soon realised that to enable cave entrance occurrences to be documented in an orderly fashion, a network of permanently-marked numbered points arond the perimeter would be necessary. Cave entrances were in such profusion and natural features which could be described and recognised unambiguously were few and far between.

As a bonus, the perimeter network, if surveyed accurately, would provide the horizontal control "backbone" for an overall tower map. The closure error in a loop completely surronding the tower would provide an indication of survey accuracy. A surveyor working for the Queensland Forestry Department (which then administered the National Parks) established perimeter surveys around several towers (including Royal Arch Tower CH5158, 5159 and Spring Tower CH5255) with magnetic compass and steel band.

Chillagoe Caving Club was formed in 1973 with the inspiration of Vince Kinnear, and the first major club project was the mapping to CRG grade 5 of the Queenslander System (CH15). Surveying was in feet and inches, and a series of sectional (although not modular) maps was produced by Tom Robinson and many helpers. The first metric tower map was of Con Tower (CH5160) by the present author and others (1973), where again a compass-and-tape perimeter survey was done to establish the relative position of the three known caves in that small tower. Since that date various other cave maps have been drawn, with the appearance also of occasional magnetic-based perimeter surveys, including those of N. Smith (1978) and T. Porritt and D. Smith (1982) which employed tripod-mounted instruments.

However, the main thrust of the club's mapping program at Chillagoe has followed a "top-down" approach. An overall map at 1:50 000 has been produced showing the locations of all numbered towers, and an individual map of each tower at 1: 5 000 prepared from aerial photography. This is largely the work of Les Pearson. Each cave entrance is shown in its estimated position on the tower map and an approximation to the Australian Map Grid is superimposed. These maps (Chillagoe Caving Club,1982) provide an indispensable guide to cavers visiting the area and greatly aid in documenting new finds. During the preparation of the small-scale mapping by the club, the surveying the caves themselves has taken a secondary role.

SURVEY WORK IN 1983

In late 1983 the author spent nearly two months at Chillagoe engaged in exploration and surveying. Of chief interest was the Walkunder South Tower (CH5170) which was known to contain three caves, Uncle Ron's Cavern (CH135), September Cave (CH218) and Fireman's Pole Cave (CH234). A partial perimeter survey had been done so that relative positons of CH135 and CH218 were known reasonably well. The aims of the trip were to extend the perimeter survey to surround the tower completely, to survey in the positions of entrance tags relative to it, and to explore more thoroughly the three caves with a view to connecting them, together with the production of a modular series of maps of these caves.

In the event, all these aims were achieved, and the perimeter survey was extended to cover also the nearby towers Walkunder (CH5167) and Walkunder Central (CH5168). Several caves in these latter two towers were also mapped. With the modular system adopted any future mapping in the immediate area can readily be incorporated into the whole.

In most cave areas direct surface survey traverses are run between entrances to establish relative position. The more direct the traverse the less the accumulation of error. At Chillagoe, entrances which are quite close together may be on opposite sides of the tower, and a direct traverse impractical due to the nature of the steep and uneven terrain. By contrast, the open savannah around the towers is ideal surveying country. This is one principal reason for the use of perimeter networks. However, a complete loop around a tower may be 3 to 6km in length, and to be useful the survey techniques must be accurate. Previous perimeter networks, while useful for recording nearby entrances, are of dubious quality for cave mapping.

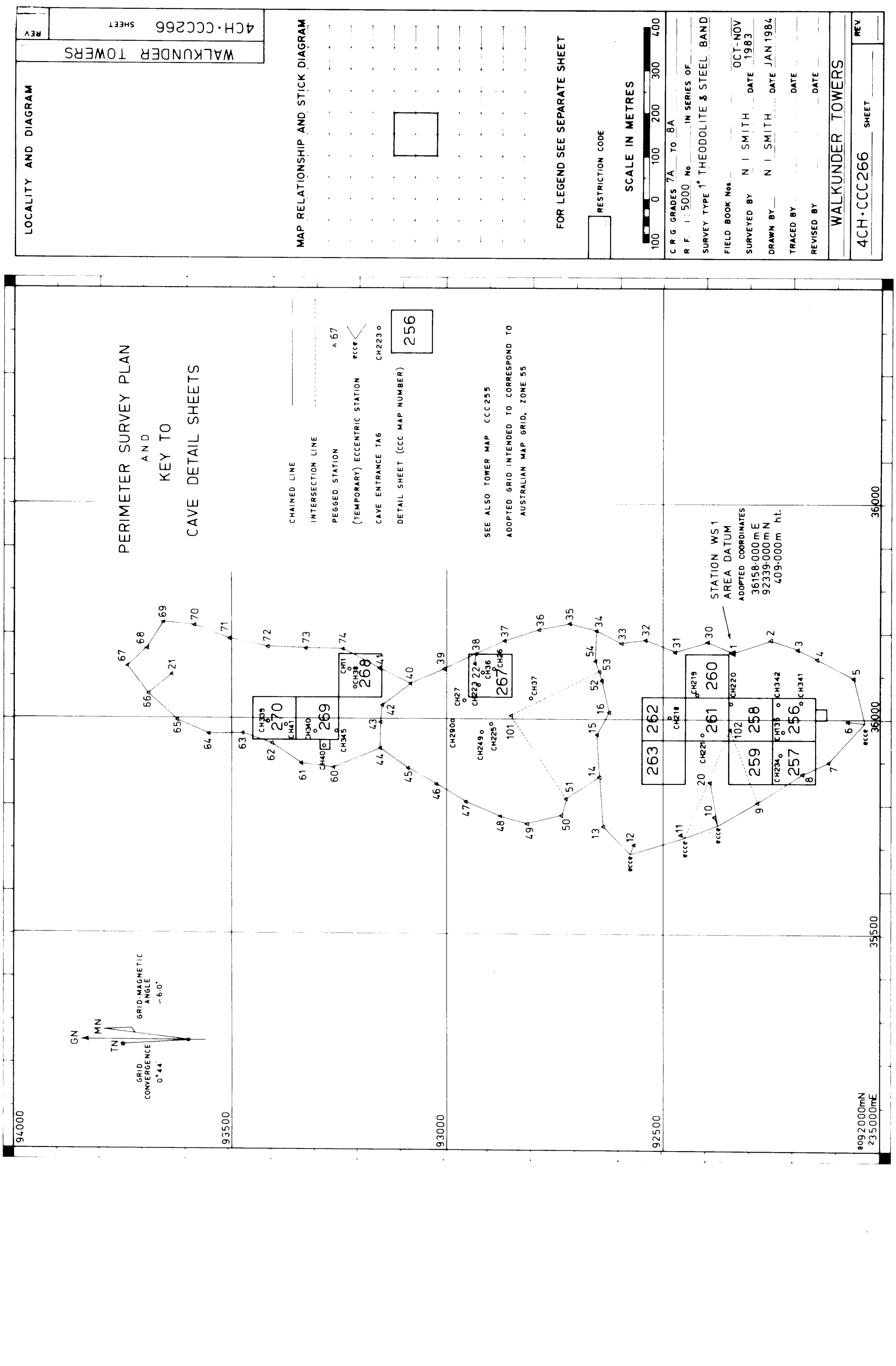


Figure 1. Perimeter survey plan.

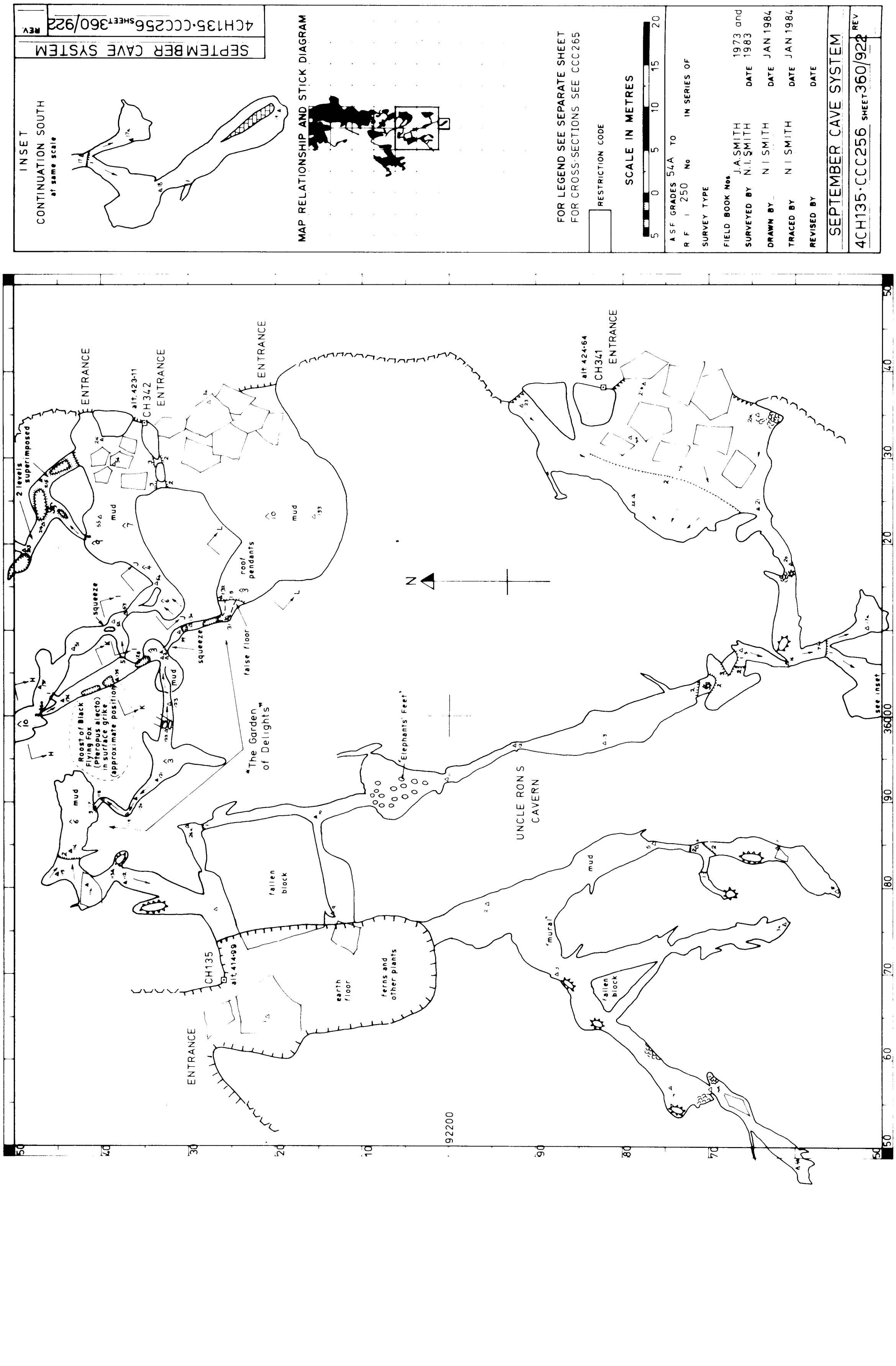


Figure 2. Example of cave detail map.

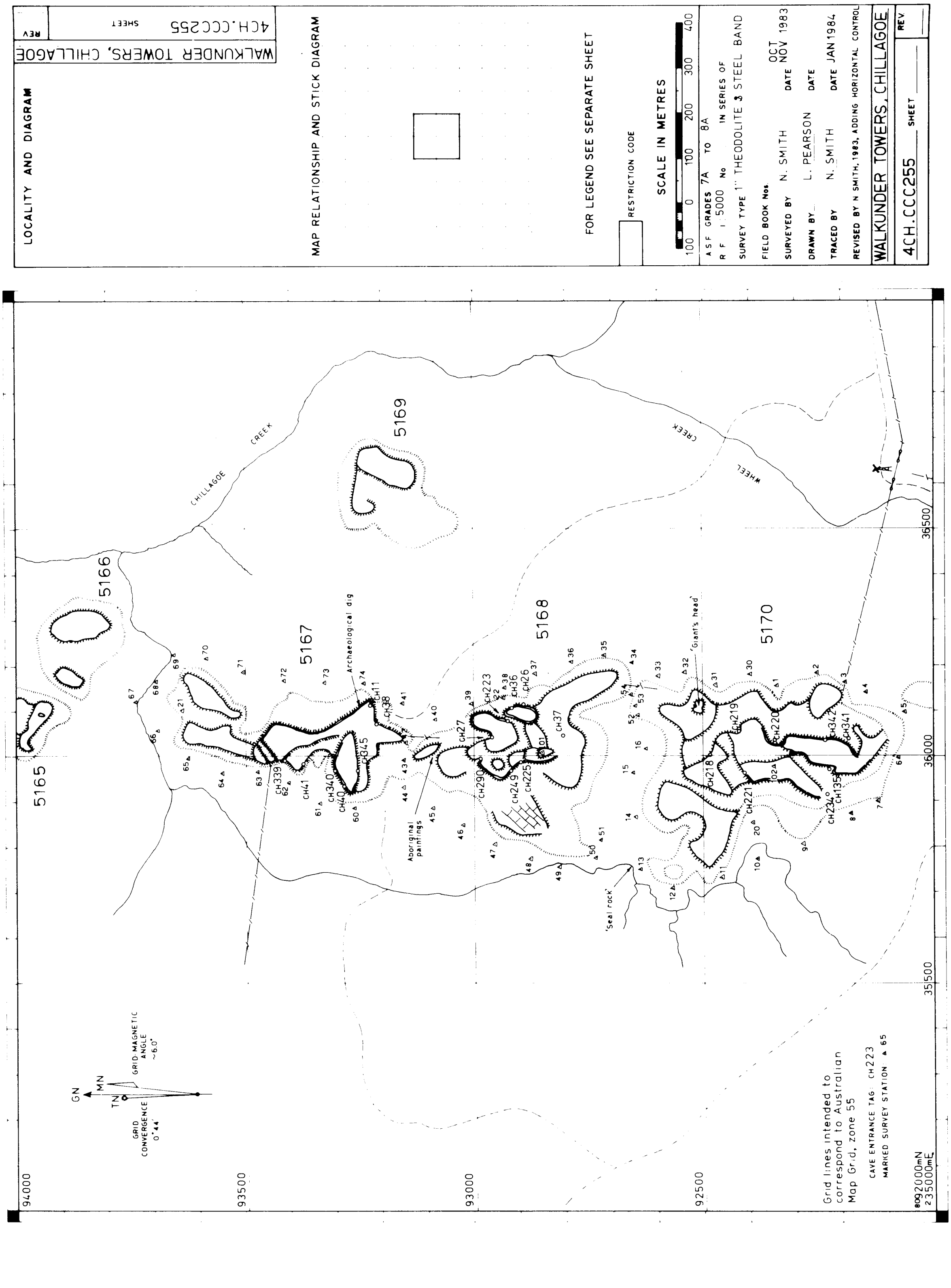
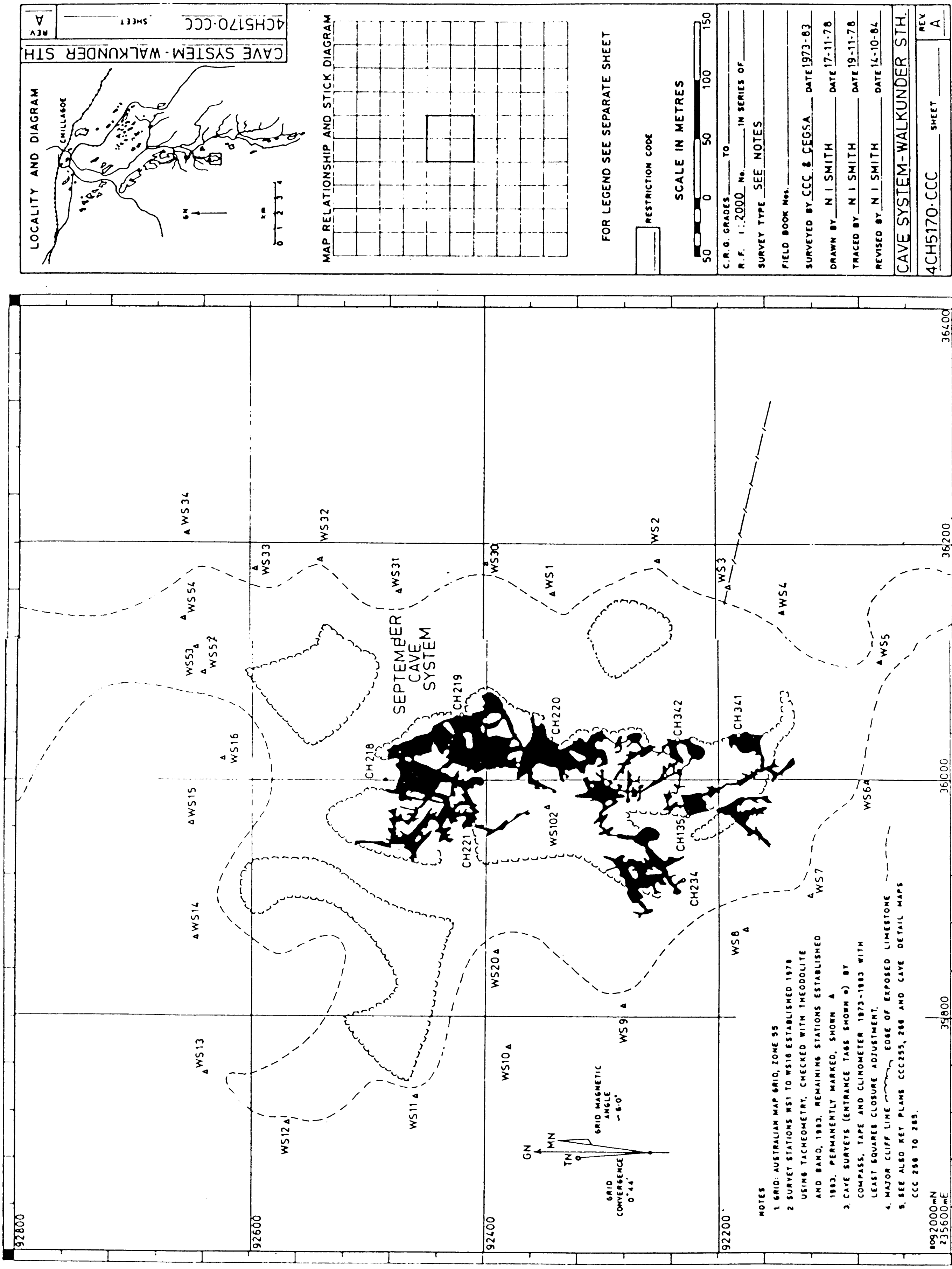


Figure 3. Tower map.


CAVE SYSTEM-WALKUNDER STH
4CH5170-CCC
SHEET
REV
A
LOCALITY AND DIAGRAM
CHILLAGOE
GN
km
0 1 2 3 4
MAP RELATIONSHIP AND STICK DIAGRAM
FOR LEGEND SEE SEPARATE SHEET
RESTRICTION CODE
SCALE IN METRES
50 0 50 100 150
C.R.G. GRADES ___ TO ___
R.F. 1:2000 No. ___ IN SERIES OF ___
SURVEY TYPE SEE NOTES
FIELD BOOK Nos.
SURVEYED BY CCC & CEGSA DATE 1973-83
DRAWN BY N I SMITH DATE 17-11-78
TRACED BY N I SMITH DATE 19-11-78
REVISED BY N I SMITH DATE 14-10-84
CAVE SYSTEM-WALKUNDER STH.
4CH5170-CCC SHEET
REV
A
SEPTEMBER CAVE SYSTEM
CH218
CH219
CH220
CH221
CH342
CH341
CH135
CH234
WS1
WS2
WS3
WS4
WS5
WS6
WS7
WS8
WS9
WS10
WS11
WS12
WS13
WS14
WS15
WS16
WS20
WS30
WS31
WS32
WS33
WS34
WS52
WS53
WS54
WS102
92800
92600
92400
92200
36400
36200
36000
35800
8092000mN
235600mE
GN
MN
TN
GRID MAGNETIC ANGLE ~6.0°
GRID CONVERGENCE 0°44'
NOTES
1. GRID: AUSTRALIAN MAP GRID, ZONE 55
2. SURVEY STATIONS WS1 TO WS16 ESTABLISHED 1978 USING TACHEOMETRY, CHECKED WITH THEODOLITE AND BAND, 1983. REMAINING STATIONS ESTABLISHED 1983. PERMANENTLY MARKED, SHOWN ▲
3. CAVE SURVEYS (ENTRANCE TAGS SHOWN ●) BY COMPASS, TAPE AND CLINOMETER 1973-1983 WITH LEAST SQUARES CLOSURE ADJUSTMENT.
4. MAJOR CLIFF LINE ___ EDGE OF EXPOSED LIMESTONE ___
5. SEE ALSO KEY PLANS CCC255, 266 AND CAVE DETAIL MAPS CCC 256 TO 265.

The 1983 perimeter work was performed with a Wild T2 "one second" theodolite and a 100m steel band. Sighting targets were made which could be accurately located over a station by means of a plumb bob. Using these techniques a network of 49 stations are established around the three towers, and over a total distance of about 4km a loop closure error of 300m was achieved. The three towers are separated by low vegetated limestone ridges across which surveying is practicable. Two cross-bracing traverses were run through these, with even smaller closure errors. A least-squares process (Smith,1979) was used to adjust all closures simultaneously.

All perimeter stations were monumented with yellow-painted steel stakes driven about 50cm into the ground, tags being attached to the top with wire. Relative levels of all of these stakes were also determined, by a combination of techniques. Initially, vertical angles were read on the theodolite at the same time as the horizontal traversing was done. With careful measurements also of target and instrument heights the relative station heights could be determined to about 10mm. However, this was rather time-consuming and it was later realied that a separate levelling traverse with theodolite and staff would be more accurate and quicker over the flat terrain involved. (A surveyor's automatic level would be even quicker, but we didn't have one.)

Some cave entrances (particularly those in tower CH5168) are quite remote from the perimeter and for accurate location a nearer reference point is desirable. Having the theodolite and the accurate perimater network enabled us to locate several prominent pinnacles near the centres of the towers by intersection. Heights were accurately found from measured vertical angles.

The true azimuth of the perimter survey was determined by sun shots, and knowing the grid convergence of the AMG in the region the orientation relative to the grid could be determined. However, the grid numbers themselves could not be found accurate to the 1m level since there was no marked trig. stations in the area. The best that could be done was to trace the tower outlines and grid from the Chillagoe 1:50 000 topographic map onto mm graph paper, blow this up by a factor of ten by making each mm square correspond to a 1cm square on another sheet, and then fit the perimeter survey plan around this (with the known orientation). In such a way we obtained a local approximation to the AMG, thought to be accurate to about 10m.

Surveying inside the caves, and from entrance tags to the perimeter and intersected points, was performed by conventional tape, compass and clinometer techniques. Exploration had enabled the three caves of tower CH5170 to be connected together, and the overall system (known as the September Cave System CH135) contained many interconnected survey loops, with connections to the perimeter at four points. Again, the closure errors were adjusted out by the least-squares simultaneous adjustment technique of Smith (1979).

MAPPING WORK

A variety of maps has been produced as a result of the 1983 work. Map CCC266 at 1:5000 (reproduced here in photo-reduced form as figure 1) serves as a record of the perimeter survey and also as an index to the cave detail sheets. These latter sheets are at a scale of 1:250 and each covers an area 1000m square. They are drawn on A2 size sheets (sheet copyright Cave Exploration Group (S.A.) Inc.). An example (scale reduced by 2:1) is shown as figure 2. Map CCC255 (figure 3) is an updated version of area maps CCC20 and CCC21 (Chillagoe Caving Club, 1982) to take into account the new horizontal control. Finally, figure 4 is the overall plan of the September Cave System of tower CH5170. Total surveyed passage length is 2512 metres.

ACKNOWLEDGEMENTS

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REFERENCES

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Address for correspondence: c/o Chillagoe Caving Club, P.O. Box 92, G.P.O., Cairns, Qld. 4870