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**To all owners of surveying instruments,  
that can never be trusted,  
To all instrument readers who can never  
trust their eyes.**

## **Control and calibration of surveying instruments**

Dear friends of correct readings,

As a result of unbelievable differences in the surveying of some of the larger cave systems, Thomas Bitterli started several years ago to systematically control and calibrate the surveying instruments used by cavers. The resulting measurements led some owners to change their inaccurate equipment for newer, more accurate instruments.

With the some time ago made theodolite survey in the vicinity of the easily accessible Chromatthütte it is possible to test and calibrate the surveying instruments AND the individual eyesight. There are three marked theodolite points (C1, C10, C12) grouped around a central point (C9). The test procedure is described in detail under "Calibration procedure" on the following pages. I am willing to do any evaluations necessary but you must perform the test procedure yourself.

Various trial runs on the course have shown surprising and very obvious differences. We have found systematic and reproducible differences of  $1^\circ$  to  $2^\circ$ , both with the surveying instruments and the individual eyesight.

We would like to encourage all owners of surveying instruments and everybody who frequently uses such instruments to check their equipment on this test course. This way it is possible to correct systematic, optical mismeasurements. The determination of the correction factor is also advisable for older instruments, so that the measurements obtained by these instruments can be controlled and corrected if necessary.

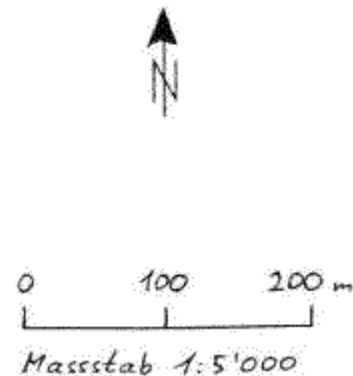
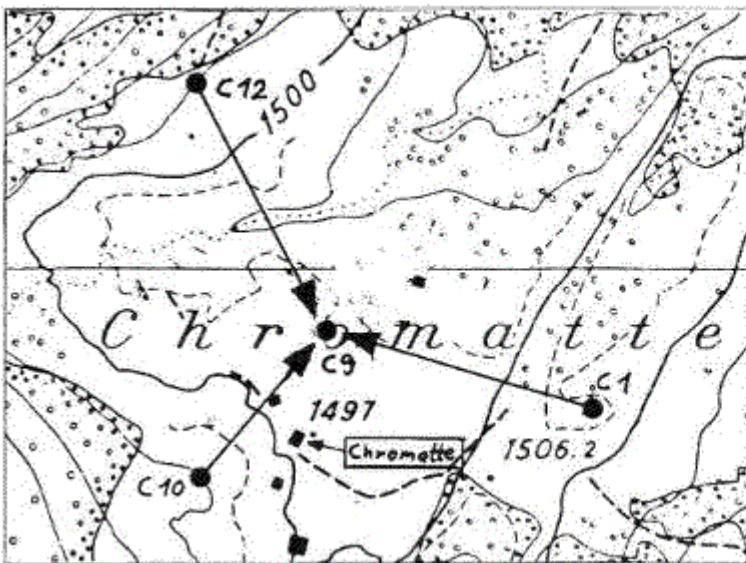
*Rolf Kummer*

## Calibration procedure

### Locality

Chromatte, Habkern (BE); survey points are marked with cartridge cases and poles.

- Coordinates central point (C9): 630'501.39/176'957.72//1500.42  
(signpost on large rock)
- Coordinates northern point (C12): 630'409.39/177'126.64//1510.82
- Coordinates southern point (C10): 630'415.73/176'858.44//1510.11
- Coordinates eastern point (C1): 630'683.80/176'905.74//1506.18  
(point of national survey).



### Procedure

- Accentuate the central point so it is easily visible from all three surrounding points.
- Measure the central point (C9) from all other points (C1, C10, C12). The inclination is only measurable from north (C12) and south (C10) without difficulties.
- Readings in tenth of a degree.
- We suggest making 20 to 25 measurements for each instrument, 20 to 25 measurements for each reader and 20 to 25 measurements for each survey point.
- Take aim with a minimum of two people (determination of optical mismeasurements).
- Take aim with only one eye. Check if your left and right eye give the same reading.
- Ensure there are no iron parts near the compass (umbrella, glasses, buttons etc).
- Lower and gently shake the compass after each reading (test of reproducibility).
- Compass: first series of readings (each person) take aim on the survey point from the left, second series of readings take aim on the survey point from the right.
- Inclinator: first series of readings (each person) take aim on the survey point from above, second series of readings take aim on the survey point from below.

### **Provisional evaluation (during surveying)**

- Major differences between instrument readings (same person)
  - ☞ instrument with poor reproducibility. Complete test series.
- Major differences between surveyors (same instrument)
  - ☞ suspected optical problem. Complete test series. Check results with more people.
- If two people get almost identical readings (same instrument)
  - ☞ probably no optical problem. Eventual corrections concerning the instrument only.
- Major differences between instrument readings and expected readings.
  - ☞ suspected systematical instrument fault. Complete test series.
- Minor differences between instrument readings (several people) and expected readings.
  - ☞ probably correct instrument and no optical problem. Number of readings for each surveying point can be reduced.

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### **Expected readings**

(specifications in new degrees, [old degrees in brackets])

instrument/year	<u>point north (C12)</u>	<u>point south (C10)</u>	<u>point east (C1)</u>
inclination	-3.44 [-3.10]	-4.70 [-4.23]	-1.93 [-1.74]
compass mid 2000	168.31 [151.48]	45.39 [40.85]	317.73 [285.96]
compass mid 2001	168.19 [151.37]	45.27 [40.74]	317.61 [285.85]
compass mid 2002	168.07 [151.26]	45.15 [40.64]	317.49 [285.74]
compass mid 2003	167.95 [151.16]	45.03 [40.53]	317.37 [285.63]
compass mid 2004	167.83 [151.05]	44.91 [40.42]	317.25 [285.53]
compass mid 2005	167.70 [150.93]	44.78 [40.30]	317.12 [285.41]

### **Evaluation**

- Send a copy of your completely filled in form to the above address.  
(PLEASE don't send me any instruments)
- Note the serial number of the used instrument, compass or inclinometer, on the measurement charts. Complete older measurement charts, too, if possible. Include survey instruments which are no longer in use in the test series.
- Note the name of the instrument reader or readers on the measurement charts. Complete older measurement charts, too, if possible.
- If you use Toporobot: note the value of the optical correction and the instrument correction in the *trips* window in the *declination* and *inclination* fields. Put a cross on *automatic declination*. Note the optical and instrument correction separately in the *comments* window.
- If you use other programmes: ensure that the declination is corrected with the right value.
- Calibrate all surveying instruments every 1 to two years.