Matzka, J., Wenger, T., Krüger, J., Morschhauser, A., Müller-Brettschneider, C. (2019): How to treat the Zeiss 010 and 020 nonmagnetic theodolites. - In: Leonhardt, R., Leichter, B. (Eds.), 18th Workshop an Geomagnetic Observatory Instruments, Data Acquisition and Processing of the International Association of Geomagnetism and Aeronomy (IAGA), Conrad Observatory Journal - COBS Journal: Special issue; 5, 2018, Wien : Zentralanstalt für Meteorologie und Geodynamik, 16.

How to treat the Zeiss THEO 010 and 020 nonmagnetic theodolites

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Almost all geomagnetic observatories rely on steel-free Zeiss THEO 010 and 020 theodolites for the absolute measurement of geomagnetic declination and inclination. Keeping the presently available instruments in good condition is highly relevant for the geomagnetism community. Here, we present some guidance on operation, storage and maintenance. The user manual we find to be a valuable, possible overlooked, source of information.

Production of the THEO 010 and 020 theodolites by Carl Zeiss Jena commenced in 1971 and stopped around 1990. Special nonmagnetic and steel-free versions for use with magnetic compasses and for special measurements are mentioned in the user manual and around 500 such pieces have originally been built by Zeiss. THEO 010 and 020 that were subsequently converted steel-free are still commercially available today. The information given here is based on our experience (JK was responsible for final control and adjustment of THEO 010 and 020 at Carl Zeiss Jena), the user manual, and discussions with colleagues during the IAGA Workshop at the Conrad Observatory.

In contrast to the normal version, the nonmagnetic theodolites have no ball-bearing in the vertical axis system and therefore should be greased more often, say every 2 to 5 years. A hole in the grease film can cause irreparable damage to the nonmagnetic axis system (cold welding). Insufficient greasing makes the alidade sluggish, more harder to rotate. Due to grease and air bubbles in the vertical axis system, there should be a small vertical mechanical play between alidade and tribrach.

Operation. The instrument can be used between -25° C and +45° C. The user manual recommends to always make the final turn with the fine tuning knobs in clockwise direction for the horizontal circle and in counter-clockwise direction for the vertical circle. The spring plates of the tribrach should be fixed to the pillar.

Storage and transport. For storage and transport in the box, usually the clamps should be slightly tightened. However, for a theodolite with a fluxgate sensor on top that only tightly fits into the transport box, it might be more wise to leave the clamps open. Mechanical shocks should be avoided as they can lead to circle errors that need adjustment, or even instrument damage. After horizontal storage, the alidade should be slowly rotated a few times in both directions to redistribute the grease. Storing the instrument above +45° C rapidly weakens the cement keeping optical parts (lenses, circles, scales) and the spirit levels in place and leads to severe de-adjustment of the instrument. High temperatures also adversely affect the grease. If the instrument is stored in a small building, a car, or the transport box and exposed to direct sunlight without ventilation, then temperatures exceeding 45° C could easily be reached. Don't store a humid or dusty instrument in the transport box. Never use strong direct heating to dry the instrument. For short breaks during outdoor work, cover the instrument to protect it from rain and dust. Operate and store the instrument in a ventilated room protected from sunlight and rain. When bringing a theodolite from a cold to a warm room, let it temperate slowly inside the transport box. Growth of fungus deteriorates the optics, especially when humidity exceeds 75 % for extended periods and temperatures are above 15 °C. Use a well-ventilated, bright room for storing the instrument (e.g. operate sometimes a small ventilator close the theodolite, though remove it during observations; store smaller parts in a glass cabinet with slightly (5 K) increased temperature or with a desiccant).

Maintenance. The instrument should only be opened, disassembled and greased by a specialist. All original spare parts for THEO 010 and 020 were transferred from Carl Zeiss Jena to the company Wiethüchter in the early 1990ies and from there to Wenger-Wiethüchter in Jena around 2000. However, no spare nonmagnetic vertical axes exist. Our community would profit from sharing such specialised spare parts to make sure that a maximum number of high-quality instruments remains operational.

Acknowledgement. We acknowledge valuable discussions with our colleagues at the IAGA Workshop 2018 at the Conrad Observatory, especially with A. Berarducci, L. Hegymegi, A. Lewis, T. Raita and C. Turbitt.

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