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Comparative study of the accuracy of caesium, Overhauser and fluxgate magnetometers in field conditions

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INTRODUCTION

The presentation is a comparative study analyzing the accuracy of different types of magnetometers in field conditions. Long-term registrations and repetition profiles were measured in the field with a caesium magnetometer (Fig. 1, bottom), an Overhauser magnetometer (Fig. 1, top right) and a fluxgate magnetometer (Fig. 1, top left). In addition, the influence of the sensor carrier on the measurements for different orientations of the registration unit was investigated.

METHODOLOGY

The following tests regarding accuracy and repeatability were conducted with all magnetometers:

(1) long-term measurements at a fixed point to determine the standard deviation,
(2) repeated profile measurements in both directions,
(3) area measurements on an archaeological site to investigate the spatial resolution of the magnetometers,
(4) horizontal rotation of the sensor carrier at a fixed point to determine its influence on the measurements depending on orientation,
(5) controlled inclination tests at a fixed point tilting the sensors inline and crossline (Fig. 1, top right).

RESULTS

Long-term measurements at the same point of the gradient values of the fluxgate, caesium and Overhauser magnetometers showed standard deviations of 0.15 nT/m, 0.03 nT/m and 0.3 nT/m, respectively. Regarding reproducibility on the same profile, the best value was obtained with the caesium magnetometer combined with its carrier (3% standard deviation). The Overhauser and fluxgate magnetometers showed a standard deviation of 15%. The results of area measurements showed that the fluxgate magnetometer has a better spatial resolution of contiguous anomalies than the caesium-magnetometer, although the latter has higher resolution. The measurements could not be improved using smaller profile spacings with the Overhauser and caesium magnetometers.

A 360° periodical azimuthal rotation of the equipment carrier and installations on the sensors influenced measurements with fluxgate and Overhauser magnetometers. Depending on the type of construction, the standard deviations are between ±1.5 nT/m and ±6 nT/m.

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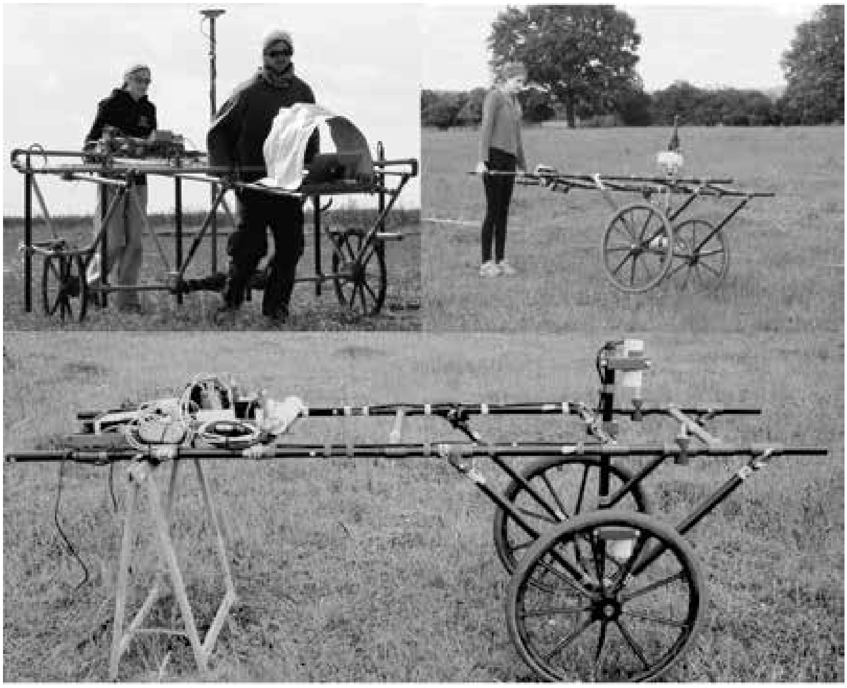

Fig. 1. Top left: equipment carrier of the fluxgate magnetometer with DPGS positioning; top right: inclination tests with Overhauser sensors; bottom: measurement setup for caesium magnetometers with manual positioning

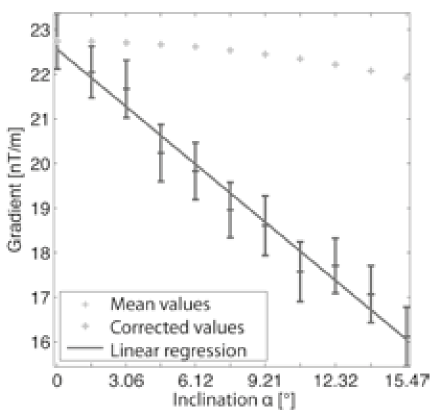

Fig. 2. Mean value and standard deviation of the gradient of the Overhauser magnetometer, plotted with regression curve and geometrical correction

The results of the inclination tests for the Overhauser magnetometer are presented in Fig. 2.

The mean gradient values of the Overhauser and caesium magnetometers show a linear change of 0.5 nT/m per 1° with increasing tilt angle of the instrument carrier and the sensor. This is confirmed with a regression curve of $-0.4205\,\alpha+22.5585$ nT (with the inclination angle α). The correlation coefficient is -0.9895. The linear change is mostly due to geometrical effects, a "back tilting" reduces the effects to a remaining non-linear tilting of about 0.04 nT/m per 1°.

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