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Comparative High Resolution Caesium Vapour and Fluxgate Gradiometer Survey at a Range of Archaeological Sites in England

Magnetometer surveys continue to be used over a wide range of archaeological sites throughout the UK and have met with a high degree of success given the generally favourable geological and soil conditions found throughout the country (Clark 1990). The majority of these surveys have been conducted with fluxgate gradiometers which offer the advantage of both affordability and rapid data acquisition in the field, constrained only by a modest sensitivity compared to high resolution caesium vapour sensors. Whilst primarily designed for aeromagnetic applications the suitability of optically pumped magnetometers for archaeological survey has long been recognised (Ralph 1964) deterred only by the cost of the equipment and difficulties with field operation. To this end, German and Austrian geophysicists have extensively developed caesium instrumentation for archaeological applications which currently allow high resolution magnetic data to be collected at a much higher rate than the fluxgate surveys (Becker 1995).

Despite the obvious advantage of higher sensitivity that caesium magnetometers provide relatively few surveys have been conducted with caesium magnetometers in the UK compared to the continent. This is due, perhaps, to both the historical development of fluxgate instrumentation in the UK (Alldred 1964) and the abundance of magnetically enhanced soils found throughout the majority of the country (Dearing et al 1997). Numerous geophysical surveys, supported by subsequent excavation, attest to the suitability of fluxgate instruments to a provide a more than adequate sensitivity over the resultant well magnetised archaeological features that these sites produce. However, the scarcity of direct comparisons with caesium data has limited the assessment of high resolution magnetic survey and the benefits this may offer over conventional fluxgate gradiometers.

The aim of this study is to present results from a series of comparative surveys conducted over a range of sites in England through an ongoing collaboration between the Bayerisches Landesamt für Denkmalpflege, Munich, and the Archaeometry Branch, Ancient Monuments Laboratory, English Heritage. A range of monument types and geological substrates have been investigated encompassing sites both favourable to magnetic

Fig. 1. Stonehenge

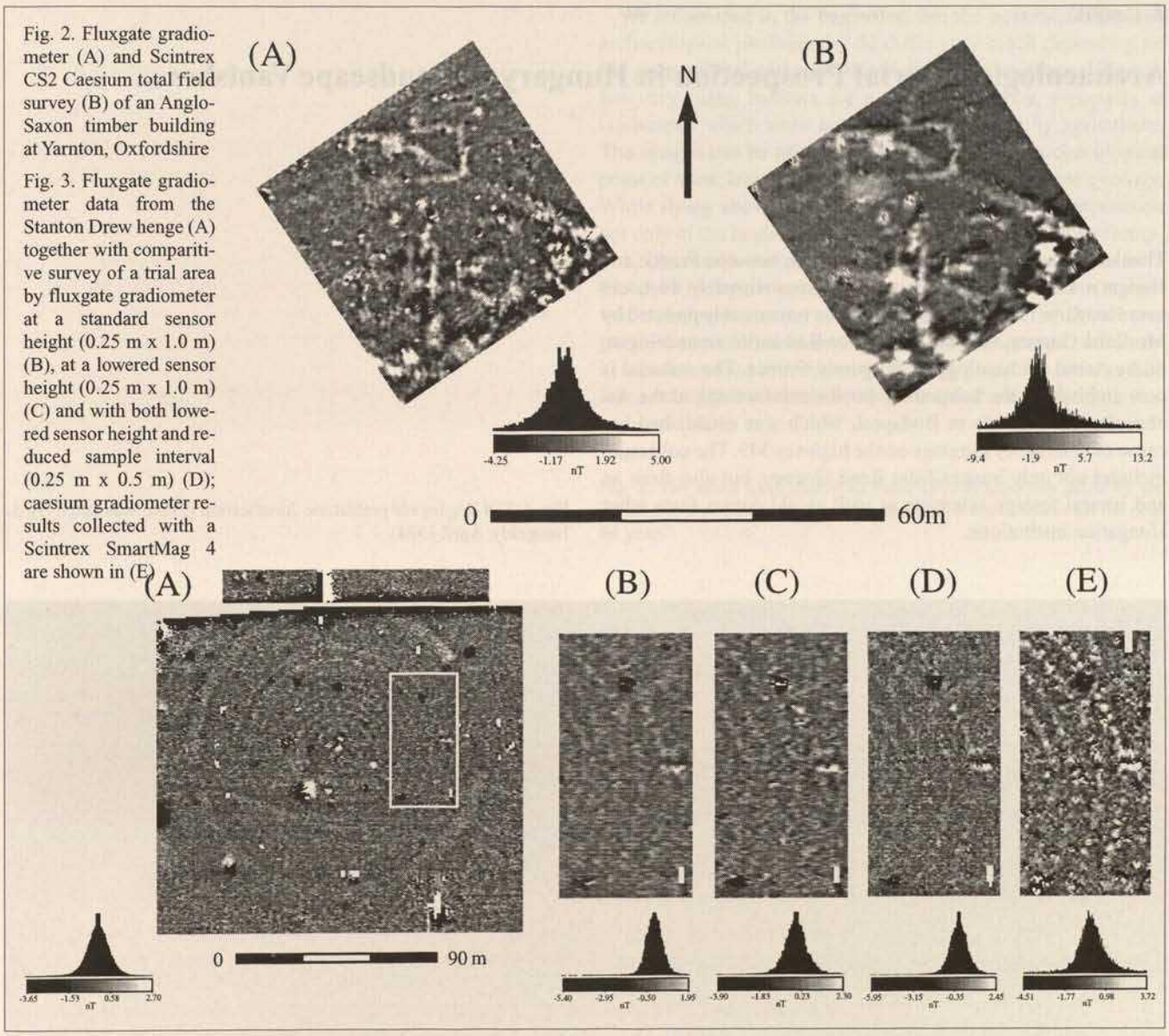

Fig. 2. Fluxgate gradiometer (A) and Scintrex CS2 Caesium total field survey (B) of an Anglo-Saxon timber building at Yarnton, Oxfordshire

Fig. 3. Fluxgate gradiometer data from the Stanton Drew henge (A) together with compariti-ve survey of a trial area by fluxgate gradiometer at a standard sensor height (0.25 m x 1.0 m) (B), at a lowered sensor height (0.25 m x 1.0 m) (C) and with both lowe-red sensor height and re-duced sample interval (0.25 m x 0.5 m) (D); caesium gradiometer re-sults collected with a Scintrex SmartMag 4 are shown in (E)

survey and those where fluxgate gradiometers have met with difficulty discerning weakly magnetic anomalies. The study includes comparative magnetic data sets collected with a pair of adapted Scintrex CS2 caesium vapour total field sensors and Geoscan FM36 fluxgate gradiometers at similar sample intervals (0.25 m x 0.5 m). For further comparison, additional fluxgate data was collected at more typical reconnaissance sample intervals (0.25 m x 1.0 m) and also with a reduced sensor height, closer to the operational height of the CS2 sensors, to maximise the response from weakly magnetised features.

Figure 2 illustrates the results of a comparative survey of an Anglo-Saxon timber building at Yarnton, Oxfordshire, where both fluxgate and caesium instruments have detected a rectangular anomaly due to the building and other associated activity. It is of interest to note the discrepancies arising in the interpretation dericved from the two magnetometer plots which, no doubt, reflect a combination of instrument sensitivity and differing levels of confidence applied by the two research groups during the analysis of the data. This issue is explored further at sites, including Yarnton, where excavation following the geophysical survey has allowed a direct comparsion between significant magnetic anomalies and the underlying causative features.

Results are also presented from a similar comparsion between fluxgate instruments and the commercially available Scintrex SmartMag 4 caesium vapour gradiometer conducted over the site of a suspected timber temple revealed wthin the Stanton drew stone circle, W England (Fig. 3). Whilst the SmartMag has a much lower sensitivity than bespoke systems derived sensitivity over fluxgate gradiometers.

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