Application Note: Magnetic Gradiometers for Archaeology

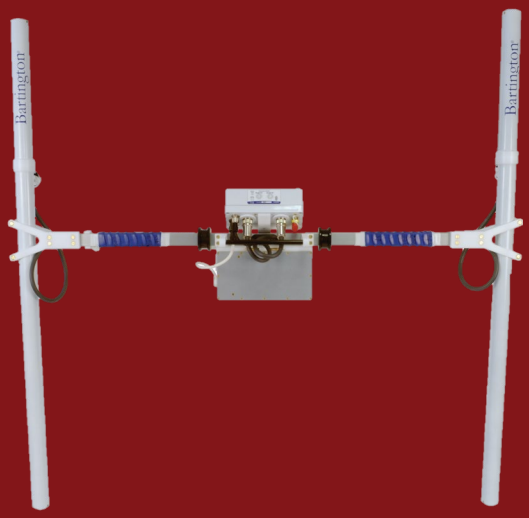
OVERVIEW

In order to understand the evolution of human civilization, we have tried to identify and understand how groups were organized and what type of activities they had.

Whilst finding artifacts provide some essential information, not all activities have led to easily identified physical markers. Instead some activities left traces in different form which have affected or altered the electrical and magnetic properties of the soil. These can now be used to map past occupied sites.

Equipment

- Grad601 and Grad-13 Magnetic Gradiometers



Applications

- Map the underground structures associated with past human activities

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Magnetic Gradiometers application in Archaeology

There are a few methods which are used to image underground structures. Resistivity and GPR can be used, but magnetics tend to be one of the most commonly employed method. It relies on subtle changes in the magnetic properties of the ground which leads to some local variations of the magnetic field at very small scale.

Because of the scale of the variations, two fluxgates separated by 1m will see different response from the shallowly buried feature and 'map' the magnetic anomaly.

Anomalies arise from different phenomenon. The first is the presence of a magnetic susceptibility contrast within the soil. Over time, the soil will naturally develop some magnetic susceptibility stratification. The action of digging (trenches, posts, ditches etc) will therefore excavate some material of different susceptibility. Over time these may get back filled with soil of intermediate susceptibility. This contrast, even though quite small, is sufficient to interact with the Earth's magnetic field and create a discernable magnetic anomaly which is then used to map the location of ditches or old enclosure. The same mechanism can also be at play in the case of ancient way of transportation where compaction could lead to distinctive susceptibility.

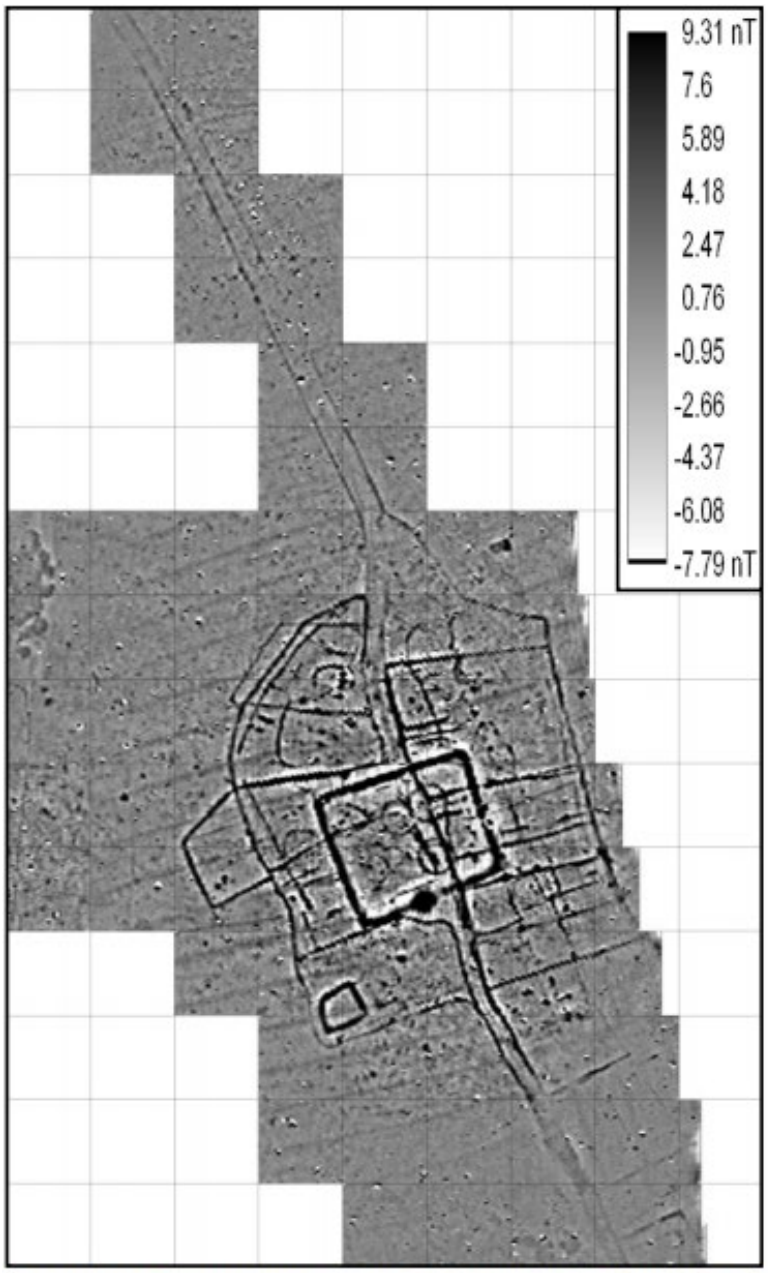


Figure 1. Geophysical Survey of a Roman settlement, Hinton Wildrist (Grids are 30 metre squares. North is at the top.)

In other cases, the magnetic enhancement of the soil is driven by chemical changes in the mineralogical content of the soil. This can occur for example when the soil is subjected to high temperature which can change the redox environment and alter mineralogical phases of iron from low susceptibility to high susceptibility ones for example. This mechanism can be extremely effective as long

as the iron mineral are present within the soil and that there is sufficient additional matter to create the correct redox atmosphere.

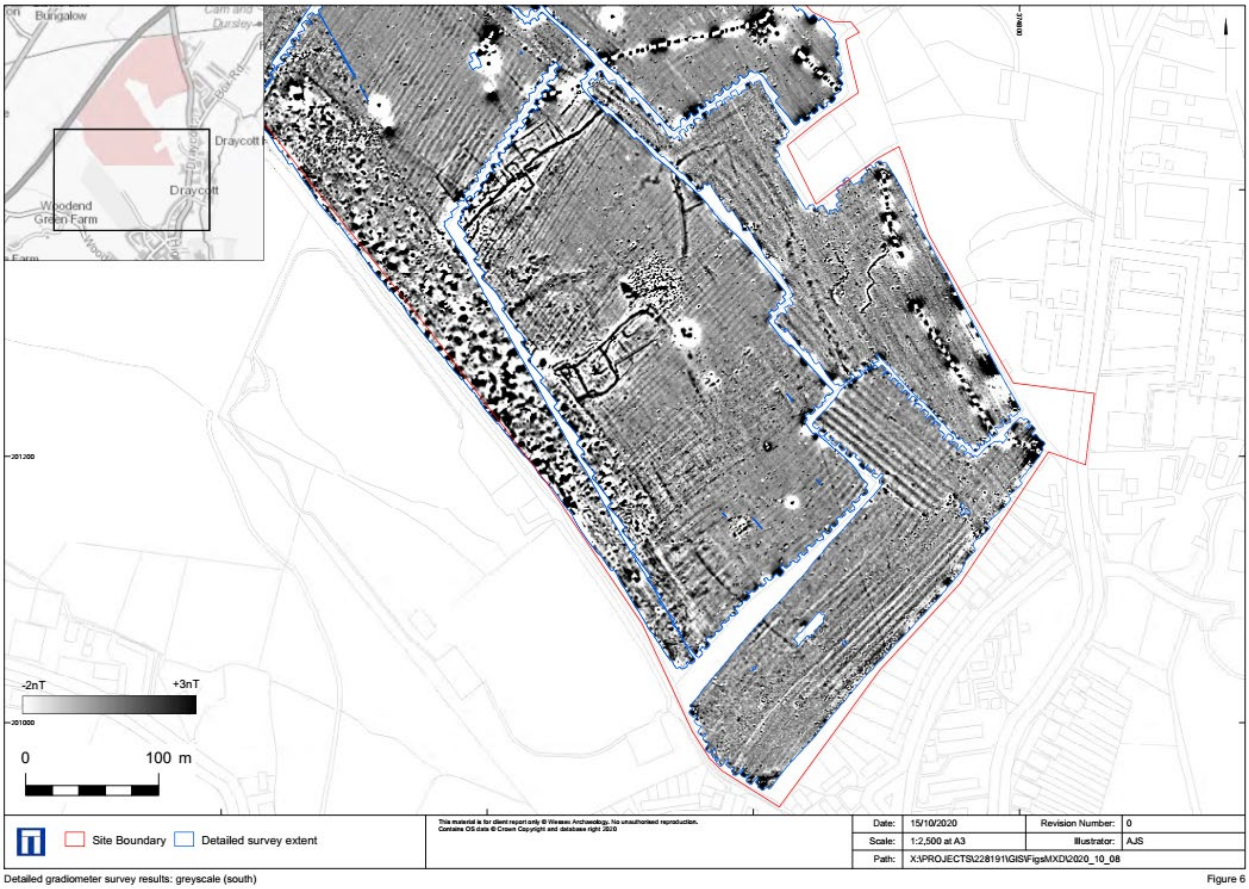
An example of a survey can be seen above – here from a survey carried out by the University of Oxford in the village of Hinton Waldrist. For further interpretation, please refer to the case study published on our website (insert link here).

Gradiometer survey on Cart

Where ground conditions are suitable, multi-sensor surveys are possible, with the sensors mounted on a carbon-fiber cart that can accommodate up to 12 sensors with the necessary DL601 logger and battery. This has the benefit for existing owners of Grad601 to reduce the amount of equipment required to upgrade to cart-based surveys.

The system requires the DL601 to have an NMEA output, and datalogging is performed via a third-party software which collect the GPS and magnetometer data and allocate position data to each of the sensors based on the cart setup.

Example of a survey can be seen below. The full report is from Wessex Archaeology and can be found at https://docs.planning.org.uk/20210917/130/QXB4FFPN0D300/8vc9ex287dik3dbo.pdf for full details of the instrumentation and interpretation.



Detailed gradiometer survey results: greyscale (south)

Figure 6